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U. S. BATTLESHIP WISCONSIN EXCEEDS 17 KNOTS SPEED ON OFFICIAL TRIAL.

On her trial last month the battleship *Wisconsin* attained a maximum speed of 18.54 knots, and her average rate for 32 knots was 17.9 knots, the average for the entire trial figuring out 17.1 knots, subject to tidal

been successfully run she will doubtless soon be added to the list of fighting ships in commission. The *Wisconsin* is classed as a sea-going coast line battleship, and is of these dimensions: Length on load water line, 386 ft.; beam extreme, 72 ft. 2 1-2 in.; draft mean, 23 ft. 6 in.; gross tonnage, 6,802 tons, and



U. S. BATTLESHIP WISCONSIN, BUILT BY THE UNION IRON WORKS, SAN FRANCISCO, CAL.

corrections. Thus again has the Pacific coast demonstrated that it can turn out war vessels which are the peers of any constructed elsewhere in the world. This fine fighting ship came into being at the birthplace of the famous *Oregon*, the Union Iron Works, San Francisco, and now that her trial has

displacement with two-thirds ammunition and stores aboard, 11,525 tons. Her designed speed was 16 knots with 10,000 I.H.P. Her construction was authorized by Congress in the act of June 10, 1896, and the contract for her construction was signed September 19, 1896. On February 9, 1897, the keel was laid, and on

October 11, 1900, the official trial was run. From an inspection of the photograph reproduced on our frontispiece, the handsome appearance of the vessel will be noted. She has a high freeboard forward and amidships, and has a pronounced ram bow, and little or no shear. The masts extending upward from the fighting tops are for signal purposes only, and the two smoke pipes are abreast, differing in this respect from most of the other ships in commission. Altogether she has a very trim and fighting appearance. Her chief weapons of offense, the four 13-in. guns, are carried in pairs in two turrets, one turret forward and one aft, and in addition she has fourteen 6-in. rapid-fire guns, sixteen 6 pdrs., and four 1 pdrs., besides various machine and landing guns. There are also four torpedo tubes for the long Whitehead torpedoes. The armor protection ranges from 16 1-2 in. on the sides, 15 in. on the barbettes, 14 in. on the turrets down to 2 3-4 in. on the flat of the protective deck.

Earlier in the month, what might be called an endurance test of the vessel was carried out on a run down the coast from Seattle to San Francisco. On this trip she covered 806 knots in 59 hours, making an average speed of about 14 knots. During this run the machinery worked without the slightest hitch.

Subsequent to the official trial of the *Wisconsin*, congratulatory telegrams, referring to her performance, passed between various heads of the Navy Department in Washington, and the builders in San Francisco.

The contract price of the hull and machinery was \$2,674,955. When in commission her complement will be 40 officers and 449 men.

WORK AT SPARROW'S POINT.—Work in the marine department of the Maryland Steel Co. is very brisk just now. There are orders on hand for eleven new vessels, and for repairs to four old ones. The displacement of the new ships reaches 97,000 gross tons; and the horse power is 50,000 I. H. P. The number of engines to be built is nineteen, and of boilers fifty-two. Contracts for the two new steel freight steamers for Kidder, Peabody & Co., of Boston, call for two vessels of the following dimensions: Length over all, 505 ft.; between perpendiculars, 490 ft.; beam, 58 ft.; depth, 40 ft. They will be built to conform to the British Corporation shelter deck class of the highest rating. Each vessel will have engines of 4,000 I. H. P., and four boilers fitted with Howden draft, built for a working pressure of 20 lb. per sq. in. The speed will be 12 knots loaded. The dead weight capacity at 27 ft. draft is 11,200 tons, cargo and coal. These steamers will be operated by the newly organized Boston Steamship Co., of which Alfred Windsor is president.

On a preliminary trial of the U. S. destroyer *Bailey* in the Hudson River the machinery worked very satisfactorily. This vessel was built by the Gas Engine & Power Company & Charles L. Seabury Company, Cons., at their Morris Heights yard on the Harlem River. She is fitted with triple expansion engines and Seabury water tube boilers. This vessel is one of the three destroyers authorized by act of Congress of March 3, 1897. The others are the *Stringham* and the *Goldsborough*.

S. Y. ARROW DESIGNED TO STEAM AT THE RATE OF 40 KNOTS.

The fastest vessel afloat is always an object of special interest to the naval architect and marine engineer, and for this reason, alone, the following description of a vessel designed to capture the blue ribbon for speed will claim attention. This vessel is the twin-screw yacht *Arrow*, designed by Naval Architect Charles D. Mosher, of New York, for Charles R. Flint, also of New York. In commercial circles throughout the country Mr. Flint is widely known as a member of the South American export firm of Flint, Eddy & Co., in addition to many other financial and commercial interests.

The *Arrow* is undoubtedly the most notable recent example of a boat intended to attain the highest possible speed. To achieve such results it has, of course, been necessary to make use of the most advanced and refined features of engineering practice, in the design and construction of both the hull and machinery. In this class of work the designer has had unusual experience, for it will be recalled that Mr. Mosher was responsible for the results attained with the steam yachts *Yankee Doodle*, *Norwood*, *Feiseen*, *Presto* and *Ellide*.

In the case of the *Arrow*, the problem which presented itself for solution was, first, the design of a form of boat suitable for the development of extreme speed, and, second, the construction of the boat and contained machinery with a minimum of weight of materials. While speed was the primary consideration, however, comfort for those carried was not lost sight of, and, indeed, this has been considered and worked out to the point of luxury. The accommodations are not "crowded" by the space necessary for the machinery equipment, as might be supposed, for there will be sleeping accommodations on board for twenty-five persons. The machinery necessarily occupies a considerable amount of space, but by care in design this has been reduced to remarkably small compass considering the size of the plant—there are twenty-two steam cylinders on the yacht.

In the accompanying engravings the artist's idea of the boat steaming at top speed at sea is clearly displayed, and in the exact, if less picturesque, drawings the construction of the yacht and of her engines and boilers can be most clearly understood.

The chief dimensions of the *Arrow* are as follows:

Length, extreme.....	130 ft. 4 in.
Length, on water line.....	130 ft. 0 in.
Beam, extreme.....	12 ft. 6 in.
Normal draught of hull.....	3 ft. 6 in.
Draught under screws.....	4 ft. 7 in.
Depth amidships.....	9 ft. 4 in.
Displacement, normal draught of...3 ft. 6 in.,	67.66 tons
Coal bunker capacity.....	17 tons
Water tank capacity.....	1,500 gals.

This boat is fitted with six transverse water-tight bulkheads, dividing the hull into seven compartments, as follows: 8 ft. abaft the bow is a collision bulkhead, the compartment forward being used for a trimming tank, and providing a large storage reservoir for fresh water. As shown in the plans the crew's quarters are situated next abaft the collision bulkhead, and extend the full width of the vessel for 15 ft. of its length.

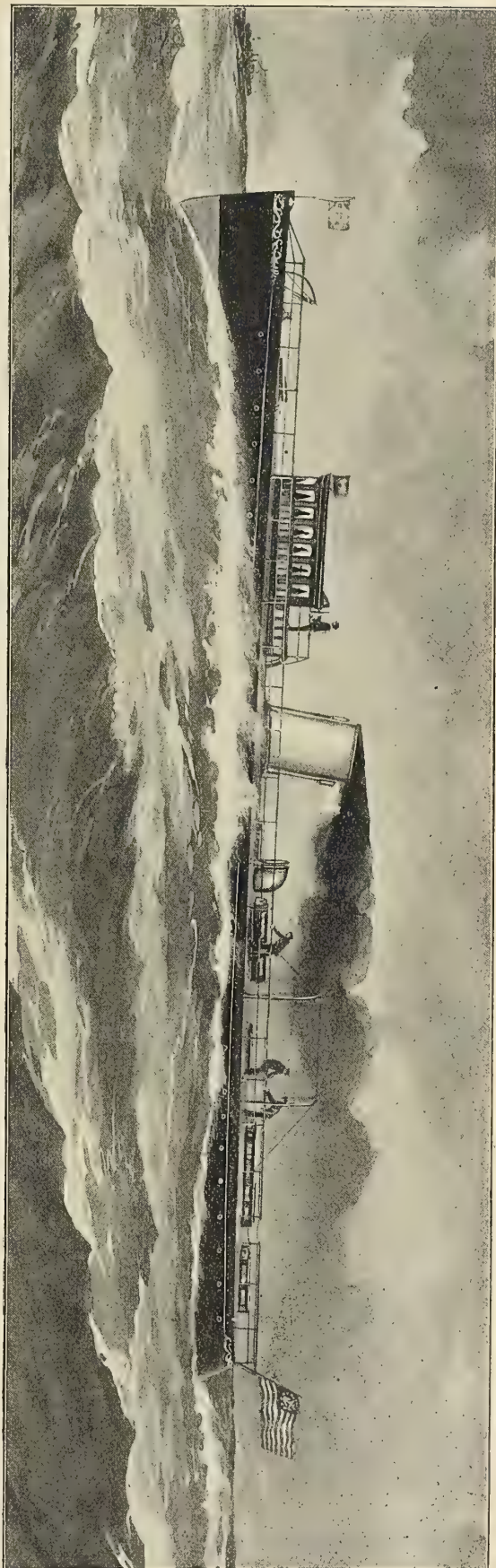
Ample accommodations and folding berths, lockers, toilet, are provided for twelve men.

Next to the crew space are located the officers' quarters, consisting of a double state room, which is also the full width of the boat, and 7 ft. 6 in. long. It contains a desk, two extra folding berths, two large clothes presses, bureau, with ample drawers, and toilet equipment. Between the officers' quarters and the bulkhead at the forward end of the boiler space is the galley, which occupies the full width of the vessel for a length of 10 ft. 6 in. This is provided with a large range, spacious ice chest, ample closets, sink, table, sideboard, fresh water tank, and sufficient space for stores for an extended cruise. A stairway leads from the galley to the main deck. Next is the boiler-room, which extends to the engine-room bulkhead, and occupies 30 ft. 6 in. of the vessel's length. In this space are two boilers of the Mosher water-tube type, described in detail at a later point. Alongside the boilers are the coal bunkers, which extend nearly the entire length of the boiler space, and have a capacity of about 17 tons, while additional coal stowage space will provide for a total capacity of about 30 tons, or a sufficient amount to enable the vessel to cruise upwards of 3,000 miles. Aft of the boiler space is the engine-room, containing two of Mr. Mosher's quadruple expansion engines, in which are embodied a number of special features, referred to more particularly hereafter.

Immediately aft of the engine-room is the owner's stateroom, which occupies the full width of the ship, and is 7 ft. 6 in. long. This room will be handsomely fitted up, and will contain a large double berth, chiffonier, clothes press, wardrobe and private bath and toilet. The joiner work is of satin wood. It will be lighted by a monitor top and four large port lights, and at night by a number of incandescent lamps. Next aft, is the saloon, which is 13 ft. 6 in. long, and occupies the full width of the boat. It is to be the most luxuriously fitted up, and will contain a grand piano, library, an octagon buffet in each after corner and gun racks, etc., for a full sportsman's outfit. The saloon is arranged to be converted into four state-rooms by hanging draperies, and is lighted by numerous clusters of incandescent lamps of variegated colors. These lamps are connected through an ingenious switch, by means of which any color of light may be had as desired. The joiner work is to be of English oak and the ceiling of Hungarian ash. The saloon is lighted by eight large port lights, besides being lighted and ventilated by a monitor top through which leads the companionway. Aft of the saloon is a double state-room, finished in Hungarian ash, and elaborately furnished, being fitted with two large berths, dress-case, large chiffonier, a wardrobe, folding wash basin, etc. This is lighted also by a monitor top, as well as by four large port lights. A toilet-room is arranged to open conveniently from both the saloon and state-room.

Aft of the state-room is the after-collision bulkhead, and aft of this is a fresh water tank holding 300 gals., and also a store-room of 300 ft. capacity. It will be noticed that the deck is particularly roomy, being clear of the usual houses. The pilot-house, the only deck-house carried, is 15

ARTIST'S SKETCH OF THE ARROW—57.66 TONS DISPLACEMENT, 4,000 I.H.P.—FITTED OUT AS A YACHT AND STEAMING FULL SPEED AHEAD AT SEA.

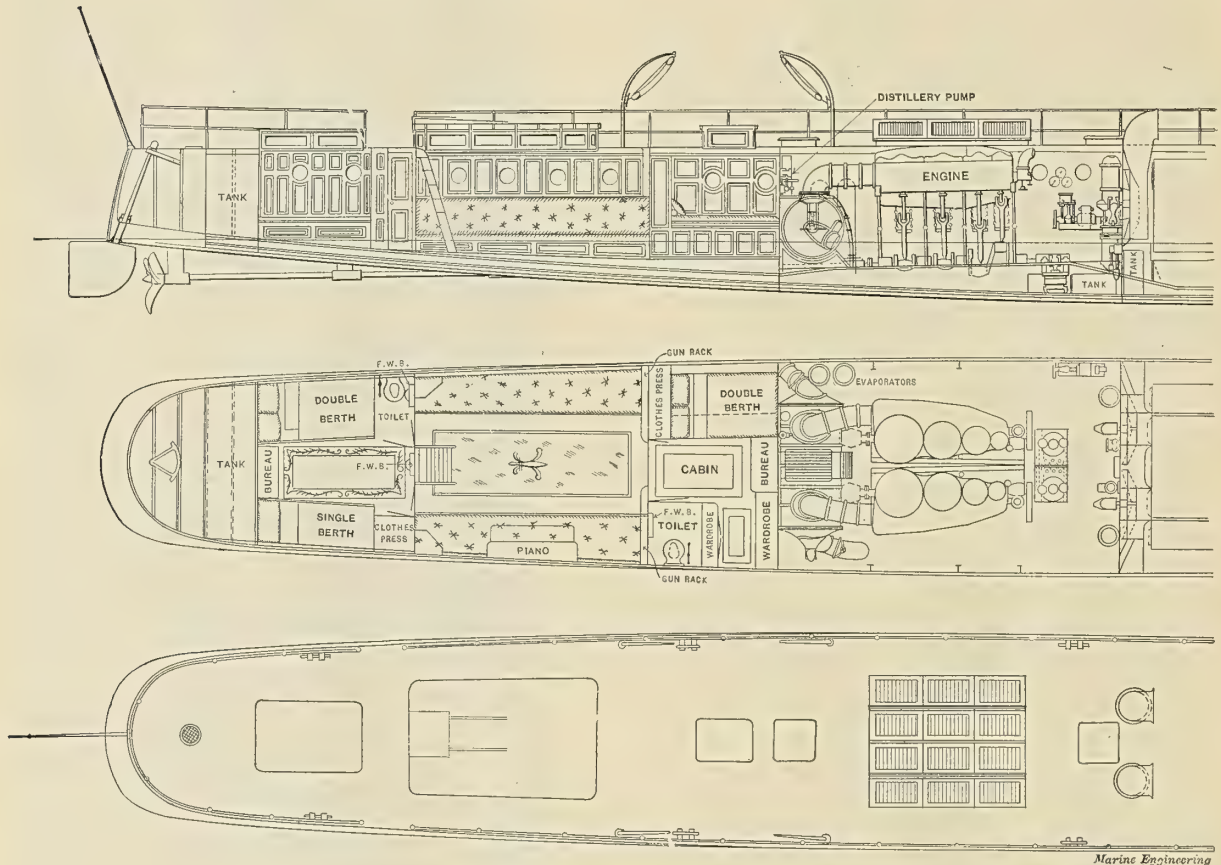


ft. long, and is arranged to be used as a dining-room. The after portion is divided off and arranged as a pantry, and is provided with silver and china closets, and is also fitted with a dumb waiter, which connects with the galley below. It is also connected with the store-room under the bridge. Aft of the pilot-house is the bridge 2 ft. 6 in. above the deck, and fitted with steering wheel, compass and binnacle, engine-room telegraphs, and a powerful searchlight, controlled both from the bridge and within the pilot-house. Under the bridge is located a spacious store-room.

The general construction of the boat is composite

ing on the sides and bottom, as well as between the deck plating and beams, a system of diagonal strapings is fitted, consisting of thin steel plates about 8 in. in width, tapering at the ends. This diagonal bracing or strapping is built in under tension, and is intended to give rigidity to the structure, as well as to tie the boat together longitudinally, and provide the necessary transverse and torsional strength and stiffness.

Two small boats will be carried—a 15 ft. cutter and a 13 ft. dinghey. The *Arrow* is to be fitted with an extensive electric plant, capable of supply sixty incandescent lights, and a powerful searchlight. Other



INBOARD PROFILE, ACCOMMODATION AND DECK PLANS OF THE S. Y. ARROW,

in character. The frames are steel below the water line and aluminum above, except through the boiler and engine spaces, where they are of steel throughout. The keelson, all floor plates, reverse frames, bunker bulkheads, boiler saddles, engine foundations, and many other details are also of steel. The sides are double-planked, with mahogany brought to a smooth, fair surface, and highly finished. The deck is of wood, except over the boiler space, where aluminum is used. The deck beams are of aluminum bulb angles. Aluminum is also used for many other details, such as side and deck stringers, hatch framing, hatch covers, breast hooks, etc. The outer keel, stem and stern posts, flooring, pilot-house, joiner work and other like features are of selected woods to best meet their respective purposes. Between the frames and sheath-

auxiliaries include two powerful blowers for ventilation and supplying forced draft to the boilers, surface condensers, with circulating pump operated by engines of special design, bilge pumps, and six powerful ejectors, having a combined capacity of over 100 tons of water per hour.

Turning now to the boilers, we have the following principal items:

Type.....	Mosher patent curved water tube
Number.....	2
Grate surface.....	120 sq. ft.
Heating surface.....	5,540 sq. ft.
Pressure allowed by U. S. Steamboat	
Inspection.....	444 lb. per sq. in.
Weight of two boilers empty.....	12.86 tons
Weight of boilers in steaming condition.....	15.59 tons

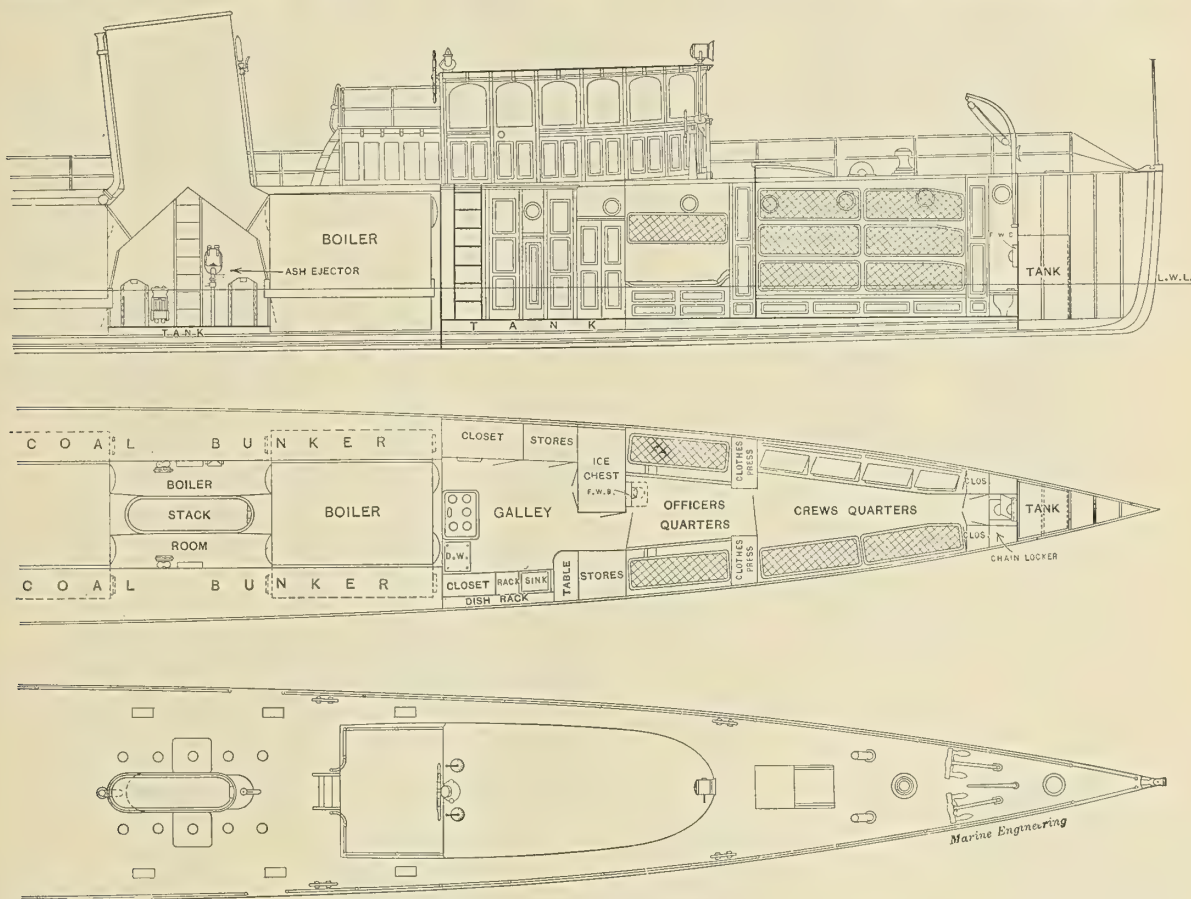
Weight per sq. ft. of heating surface without water.....	5.2 lb.
Weight per sq. ft. of heating surface with water.....	6.3 lb.

The usual full working pressure is intended to be about 400 lb. to 440 lb. at the boilers, and 350 lb. to 400 lb. at the engines.

There is one fire-room common to both boilers. In the boiler space are two specially designed blowers, two independent duplex feed pumps, two feed water regulators, and a hydraulic ash ejector, besides the usual gauges and fittings. There are two separate hatches for entering the boiler-room, each fitted with

the entire thermal equivalent of the work expended during the expansion, thus keeping the steam in a superheated condition throughout its working cycle. The reheaters are intended to aid in the drying of the steam, and to effectually prevent cylinder condensation. The air and feed pumps are just forward of the main engine, and are geared directly to the main shafts.

An important and interesting feature of the design of these engines is the arrangement of the columns and diagonal braces constituting the supporting framework of the steam and valve cylinders. This arrangement is clearly shown in the accompanying drawing,



DESIGNED BY CHARLES D. MOSHER FOR CHARLES FLINT OF NEW YORK.

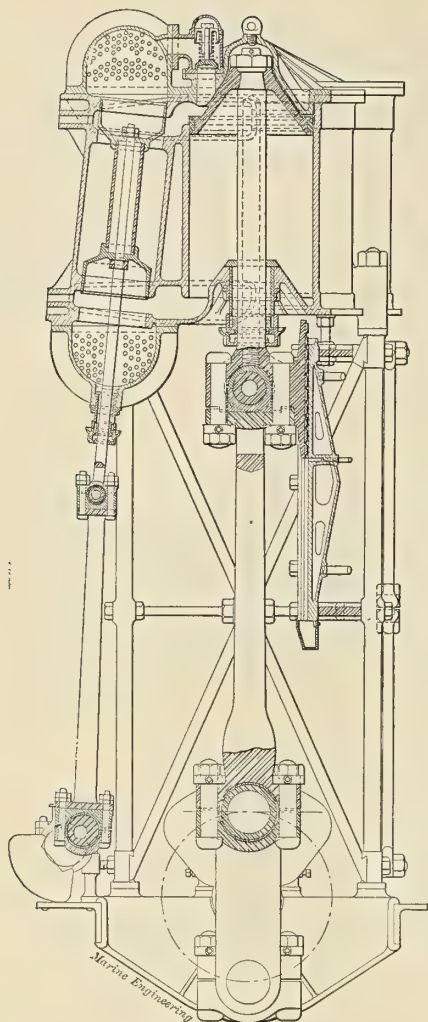
a large port light. The fire-room is lighted by four large deck lights.

Passing now to the propelling engines, we have the following chief particulars:

Type	Mosher patent quadruple expansion
Number	2
Diams. of cylinders.....	11 in., 17 in., 24 in., 32 in.
Stroke	15 in.
Working pressure at cylinders.....	350 to 400 lb.
Revolutions per m.....	540 to 600.
Piston speed.....	1,500 ft.
Calculated power developed under 540 revolutions and 350 lb., at the engine about 4,000 I. H. P.	

Both engines exhaust into one condenser, which has a cooling surface of 2,760 sq. ft. Between the steam cylinders of the engines a series of reheaters is installed, each one of which is capable of supplying

and is designed to eliminate the danger of crystallization and fracture, due to rapidly alternating compressive and tensile strains, to which the framing of extreme high speed and high-powered engines of this class is commonly subjected. It will be observed that the diagonal braces are secured together in pairs at their centers by means of a bolt and nuts, by the adjustment of which the supporting columns can be subjected to a compressive, and the diagonal braces to a tensile strain, which is intended to be in excess of any normal working strains that may come upon them. By this arrangement, it is obvious that the supporting columns will at all times be practically subjected to compressive strains only, varying in intensity as the working strains of the engine increase or relieve the initial stress due to the tension of the



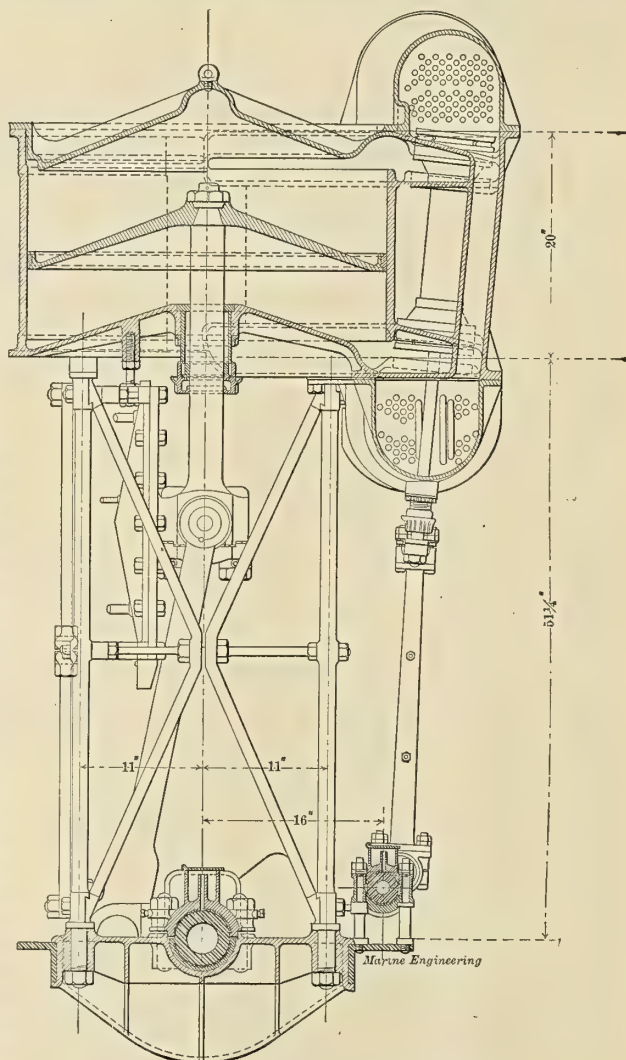
S. Y. ARROW—HIGH PRESSURE ENGINE.

diagonal braces. These braces are in turn subjected to tensile strain only, of varying intensity, but constant to the extent of taking up and absorbing practically all the initial elasticity of the structure. A remarkably rigid construction is thus attained, assuring a perfect alignment of the engine at all times, and greatly eliminating vibration, since the initial or starting movement, without which there can be no vibration, is effectually prevented.

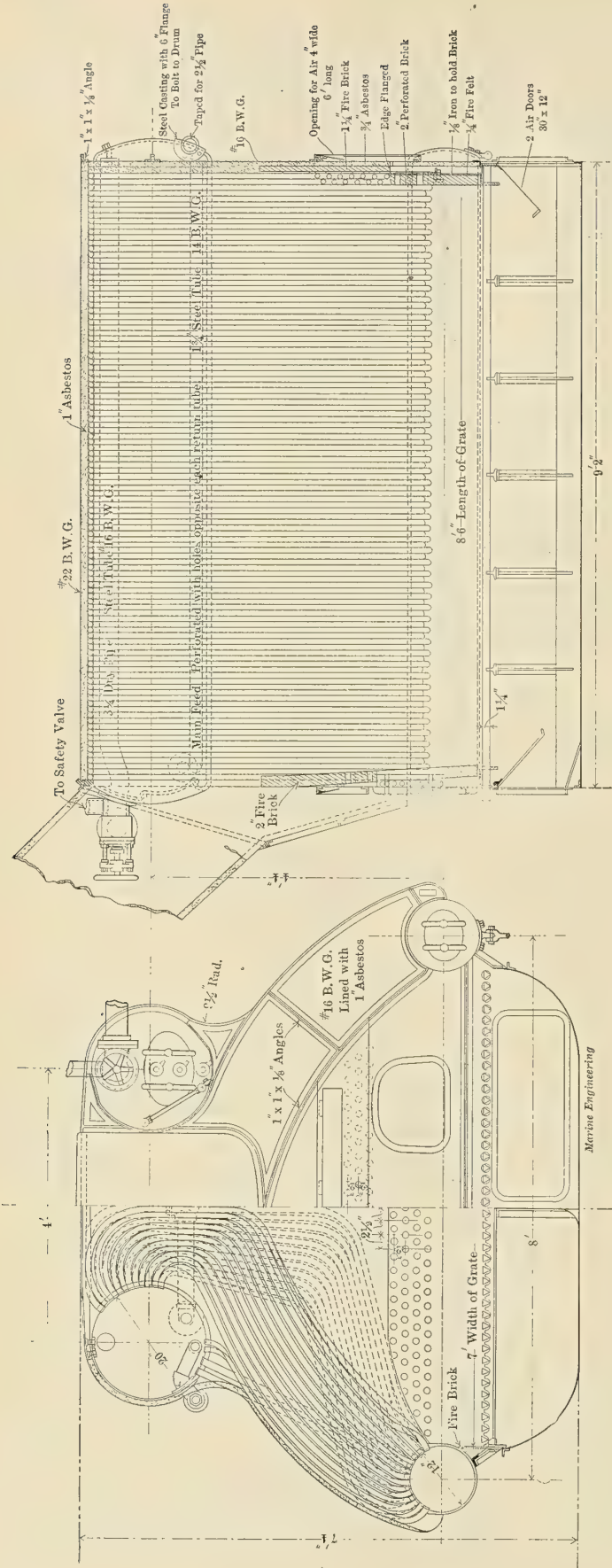
The feed water, before returning to the boilers, is heated in a pair of Mosher patent four-stage or compound feed water heaters, which are placed near the boiler-room bulkhead. This style of heater is formed of a cylindrical shell, with hemispherical ends, and a series of transverse partitions dividing the internal space into four compartments. The compartment at one end is provided with a connection for the feed inlet, and that at the other end with a like connection for the outlet. Series of tubes pass through the several partitions, and connect the two end compartments to each other, thereby forming a continuous conduit for the feed water, which thus transverses the several compartments in series. The spaces surrounding the tubes in the compartments constitute independent chambers, separated by the partitions,

and thus adapted to receive steam of different pressures for supplying the heat required. The first chamber is connected with the main exhaust pipe from the L. P. cylinder, and the feed is first heated from this source. It then passes on into the second chamber, the steam side of which is supplied from the L. P. steam-chest, or third receiver. In like manner the third chamber is supplied with steam from the second intermediate steam-chest, or second receiver, and the fourth and last chamber from the first intermediate steam-chest, or first receiver.

In this manner the feed water is successively heated by a series of transfers of heat from the expanding or working part of the steam cycle, at a series of increasing temperatures until it is finally delivered to the boiler at a temperature calculated to be about 350 degrees. It is only recently that the full thermodynamic significance of this operation has been realized. Examination shows, however, that such a series of heat transfers aid directly in bettering the efficiency of the engine, by reason of the modification which is thus introduced into the steam cycle, such modification having the effect of carrying the working cycle nearer to the ideal than it otherwise would be. The



S. Y. ARROW—LOW PRESSURE ENGINE.



SCALE DRAWING OF THE MOSHER CURVED TUBE WATER BOILERS OF THE S. Y. ARROW, BUILT FOR A WORKING PRESSURE OF 400+LB. PER SQ. IN.

lb. or 400 lb. at the engine, corresponding to a rise of about 44 deg., it would in the ideal engine correspond to a gain of nearly 11 per cent., as compared with the usual practice of 250 lb. We may next note the very considerable wire drawing from the boiler to the engine, which will tend to dry and superheat the steam and thus to aid in reducing it wastes due to internal condensation. The action of the reheaters will also serve in the same line to keep the steam dry, or even superheated, as it passes through the successive cylinders of the engine. The total number of expansions will be about 15.67, and they are carried out in a quadruple, or four-stage, expansion engine with the correspond-

ing gains which may be justly expected when using steam of such high pressure as is here employed. To these various features we must add the action of the four-stage feed water heater as described:

Then in the engine itself the cylinder clearances have been by careful design reduced to a very low value, a feature directly favorable to high efficiency of operation. Considering these various features, which will bear on the question of the economy of the engine, it seems not too much to expect an exceedingly economical development of power. It would be, of course, unsafe to predict a water rate, but it certainly would not be surprising if it should fall to the vicinity of 10 lb. per I. H. P. per hour.

A further question of the greatest interest is in regard to the speed which may be expected. Here again predictions are unsafe on account of no precedent approaching the great increase of power per unit of displacement, but considering that the form of the boat has been especially designed for the attainment of the highest possible speeds, involving a large amount of model experiment carried out by Mr. Mosher, and assuming that 4,000 I. H. P. and probably more are developed on a mean displacement of 60 tons or somewhat less for a speed run, a speed of something over 40 knots, or 46.25 statute miles per hour, is within the possibilities—a rate in excess of anything hitherto accomplished.

In the engine room, in addition to the two sets of quadruple expansion engines for propelling the boat, each of which is fitted with a steam reversing engine, there are two engines for driving the blowers for supplying ventilation and forced draft, an electric light engine and dynamo, two circulating engines for pumping the injection water for the condenser, duplex bilge and fire pumps, and auxiliary air pump for supplying a vacuum when the air pumps attached to the main engines are not running, a distilling pump, and two evaporators and distillers of sufficient capacity to supply fresh water for the entire boat service. In addition to these are the steam steering engines and auxiliary feed pumps for the boiler-room, two feed water heaters and condensers.

The hull has been constructed at the shipyard of Samuel Ayers & Son, of Nyack, N. Y., who also built the *Ellide* and other fast boats from Mr. Mosher's designs. It is all ready to receive its machinery, and will probably be launched before this reaches our readers. The boilers are nearing completion at the Crescent Shipyard, Elizabethport, N. J. The main engines and all auxiliaries have been constructed by the L. Wright Machine Works, Newark, N. J.

The boat and machinery have been designed in every part and detail by Mr. Mosher, and it is expected that the performance of the *Arrow* will surpass his past achievements in the design of high-speed boats.

On a recent westbound voyage, the White Star S.S. *Oceanic* touched bottom off the Irish coast during a dense fog. No serious damage was done, and the vessel proceeded up the Channel to Liverpool.

While trying to come alongside a wharf at Newport, R. I., the torpedo boats *Dahlgren* and *Craven* came together, October 16, and both vessels were badly damaged, but remained afloat. There was a heavy wind and sea at the time.

While the new French liner *La Lorraine* was crossing the Atlantic on the night of October 7, a fracture occurred in the forked end of the low pressure connecting rod of the port engine. The vessel proceeded with starboard engine only working, and the engineer's staff substituted a spare for the broken rod. There was a very heavy sea on at the time, and as the vessel rolled heavily, the work of repairs was necessarily slow, but after about fifty hours' hard work, the port engine was ready for business again. The remainder of the voyage to New York was accomplished without incident.

In a collision off Nantucket shoal, October 1, the Lamport & Holt S.S. *Biela*, 2,182 tons, was sunk by the British freighter *Eagle Point* bound from London to New York. The collision occurred about 1 o'clock in the morning, when most of those on the *Biela* were below asleep. They were awakened by the shock of the collision, and promptly got on deck, when the boats were lowered and all transferred to the *Eagle Point*, which was kept afloat by her forward compartment. The *Eagle Point* hit the *Biela* bows on about amidships, almost cutting her in two. The *Biela* was an old iron vessel, built on the east coast of England thirty years ago.

SIX CYLINDER TRIPLE EXPANSION ENGINES OF CHILIAN CORVETTE GENERAL BAQUEDANO.*

BY MAGNUS SANDISON.

The corvette *General Baquedano* is a training or school ship of 2,500 tons displacement. She was built by Sir W. G. Armstrong, Whitworth & Co., Ltd., to the order of the Chilian Government, and her machinery was constructed by Hawthorn, Leslie & Co., Ltd.

It was desirable that this vessel should be able to steam very economically at low speeds, and it was decided to adopt a six-cylinder engine, which I had suggested some time previously.

The steam trials of the vessel have recently been completed, and I am enabled, through the courtesy of Rear Admiral Castillo, the President of the Chilian Naval Commission in Europe, and by the permission of my firm, to lay before the Institution a brief description of her propelling engines.

The design possesses some novel features, and the arrangement forms a combination which solves with a considerable measure of success, in a simple manner, and at one and the same time, some important problems which have of recent years engaged the attention of those interested in the design and manufacture of the propelling machinery for vessels of war.

Briefly these are as follows:

(a) The production of an engine which will work with economy when developing a small proportion of its full power, and thus ensure in a given ship the maximum radius of action.

(b) The elimination, as far as possible, of the unbalanced forces in the engine.

(c) The securing, as far as possible, of uniformity in the turning effort on the crank shaft.

(d) The reduction to a minimum of the chance of total disablement.

The machinery consists of a single screw engine driving a feathering propeller, steam being supplied by four Belleville boilers, having a steam pressure of 300 lb. per sq. in. reduced to 250 lb. at the engine.

The engraving (page 457) illustrates generally the arrangement of the engine. It will be observed that, carried upon one bed-plate, there are two high-pressure, two intermediate, and two low-pressure cylinders, acting on six cranks. The high-pressure cranks are opposite and adjacent to one another, the intermediate cranks are also opposite and adjacent to one another, and 240 deg. in advance of the high-pressure cranks; while the low-pressure cranks, also opposite and adjacent, are 240 deg. in advance of the intermediate cranks.

Each high-pressure cylinder is provided with its steam stop valve. The forward high-pressure cylinder exhausts into the forward intermediate-pressure cylinder, which in its turn, exhausts into the forward low-pressure cylinder; the after high-pressure cylinder exhausts into the after intermediate pressure cylinder, which, in its turn, exhausts into the after low-pressure cylinder. Each low-pressure cylinder exhausts into its own condenser, this being provided with its own air and circulating pumps, the former being worked by levers from

*A paper read before the Institution of Naval Architects London.

the corresponding low-pressure engine, and the latter being the ordinary centrifugal type.

There are thus acting upon the crank shaft virtually two independent three-cylinder triple-expansion engines of equal size, the cranks of which are alternated with one another.

We will consider shortly some of the leading features in the arrangement.

It is unnecessary to remind members of the uneconomical performance of an engine when doing a small proportion only of the full work which it is designed to perform, or of the extravagant cost of the last knot, or two, in our fast cruisers, or of the comparatively rare occasions upon which such vessels are called upon to exert their full power.

This problem of economical propulsion at low powers has been dealt with on various occasions and in various ways. In H. M. S. *Alexandra*, built in 1875, small auxiliary condensing engines were fitted to turn the main shafts by means of gearing when the ship was under sail.

Sir John Durston, in an interesting paper entitled "Some Notes on the History, Progress and Recent Practice in Marine Engineering," read before the Institution in 1891, makes reference to various arrangements of propelling engines which have been fitted more recently in the Royal Navy, with a view to economy at low powers.

In the *General Baquedano* it will be seen that, by disconnecting and securing the bottom ends of the connecting and valve rods of one set of engines, the other set can still drive the propeller, and do so with an economy equal to that which is attained in the best Mercantile Marine practice, the cylinders being proportioned with this object in view.

The speed trials of this vessel consisted of: (1) a six hours' run at full power, and (2) a thirty hours' run at three-fifths full power. On the full power trial she steamed 13.75 knots per hour with a mean of 154 revolutions per minute.

At the conclusion of this trial the turning gear was shipped, and within an hour from that time the vessel was under weigh again, steaming with one set of cylinders only, the bottom ends of the disconnected rods being secured by means provided for the purpose.

Comparative trials of the vessel, at the same speed, under the two conditions of working, viz., with three cylinders and six cylinders respectively in operation, were not made, as the time at our disposal was limited. These were postponed until some convenient occasion after the commissioning of the vessel, and I regret I am therefore unable to place the results before the Institution.

It may be noted in passing that, in the case of the vessel under consideration, which is fitted with a feathering screw, it is possible, by reducing the pitch, to develop half power with one set of cylinders only working; but in vessels fitted with ordinary screws, and with two engines on one shaft, the proportion of power which can be developed under this condition is of necessity less.

I am not aware of any published results of trials carried out in such vessels, with the view of determining the relative economy under the two conditions; but it

would appear to be a direction in which experiments might with advantage be made.

This corvette is, it will be observed, of comparatively low speed. A cruiser whose maximum speed is, say, 23 knots, would probably steam about 19 knots with half the cylinders in operation, a speed which is as high as, or probably a great deal higher than, would be demanded from her under ordinary circumstances.

I do not, of course, suggest that with this arrangement the operation of connecting or disconnecting is one nominally of a few seconds' duration, such as would be theoretically obtained by the introduction of a disconnecting coupling between the crank shafts of two engines, one being placed forward of the other; or by driving back a set of shaft coupling bolts, both of which are usually delicate and may be vexatious operations, but it is one which forms a rudimentary part of the education of the engine-room artificer or seagoing engineer.

It should be noted in this connection, that, with the engines interlaced, as it were, the continuity and rigidity of the crank shaft are maintained under all conditions of working, and that the main bearings being always in operation, whether one, or other, or both engines be used, this shaft cannot wear out of truth as would be the case were one engine placed forward of the other on the shaft, and these bearings are always maintained in line and in working order.

It is obvious that, should it not be desired to disconnect one engine, but to have all the cranks available for instant service, steam may still conveniently be passed through either engine sufficient to merely lubricate the internal rubbing surfaces, and in no case would it be desirable to have one set of engines uncoupled under the service conditions which prevailed, for example, during the battle of Santiago, and which were alluded to by Rear-Admiral Melville of the United States Navy, in his paper dealing with Triple Screw Propulsion, read last year before this Institution by my friend Lieut. Norton, U.S.N.

As regards the balance of the arrangement, Diagram I shows, for purposes of comparison, the forces tending to produce vibration in three types of engines, the designs of which were prepared for a twin-screw cruiser of 30,000 I.H.P., the engines in each case running at 120 rev. per min. (See page 458.)

Fig. 1 is for a six-crank engine similar to that described in the paper, with the six cranks in operation, the cylinders being two of 31 in. dia., two of 50 in. dia., and two of 81 1-2 in. dia., by 48 in. stroke.

Fig. 2 is a four-cylinder engine balanced on the Yarrow, Schlick, and Tweedy system, the cylinders being 43 1-2 in. dia., 71 in. dia., and two of 81 1-2 in. dia., by 48 in. stroke.

Fig. 3 is for a four-cylinder engine of the ordinary type, the cylinders being of the same dimensions as in the preceding case.

The curves for the six-crank engine compare very favorably with those of the four-crank engines.

With regard to the conditions which prevail when one set of engines only is working, it may be remarked that, under these circumstances, not only are the reciprocating weights very much smaller than would be the case were one engine capable of developing the full power used to develop the low power, but the

cranks of the disconnected engine act in some measure as balance weights for the working engine.

A similar comparison of the twisting moments on the crank shaft for the same engines is given on Diagram II, and shows at a glance the very marked superiority of the six-crank design in this respect. In Fig. 1, *i.e.*, the six-crank design, the loads on the crank pins are equal. In Figs. 2 and 3, the loads on the low-pressure pins are half those on the high-pressure and intermediate-pressure pins, being the proportion frequently adopted in this type of engine.

The following table gives the total weight of the engines, the weight added to produce the balance shown in the diagram, and the length of engine-room in the three types of engines. (Table in next col.)

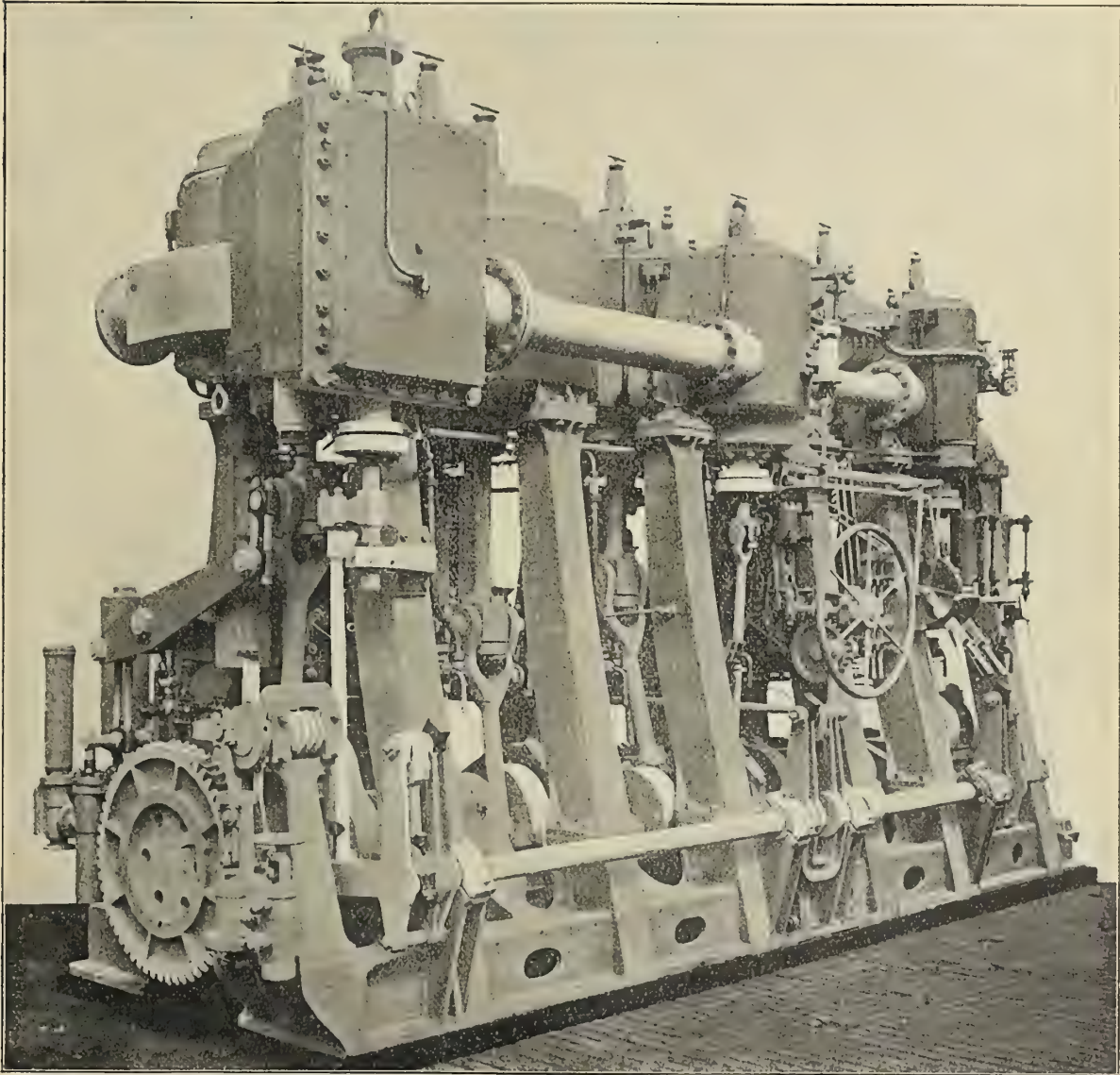
The length of the engine-room is the same in each case; but we ought not to overlook the fact that, had link motion been adopted for working the valves, the length of the engine-room in the six-crank design

would have been greater than that given in the table, unless, indeed, certain of the valves had been arranged at the back or front of the engine, and operated by means of levers in the manner which has frequently been employed both in the Navy and Merchant Ser-

Design.	Total Weight in Engine-Room in Tons.	Added Weight in Lbs.	Length of Engine-Room.
Six crank.....	1,010	5,600	ft. in. 67 6
Yarrow, Schlick and Tweedy.	975	9,826	67 6
Ordinary four-crank.....	975	8,800	67 6

vice. The type of valve gear adopted lends itself very readily to the arrangement, the weigh shafts, one on each side of the engine, being connected by a link, and worked by one reversing engine.

In order to counteract any possible tendency to set



SIX CYLINDER TRIPLE EXPANSION ENGINES OF THE CHILIAN SCHOOLSHIP GENERAL BAQUEDANO.

fast on the part of the disconnected gear, if disconnected for a lengthened period, the securing gear is so as in the case of any ordinary triple-expansion three-cylinder engine, one or both engines being worked by

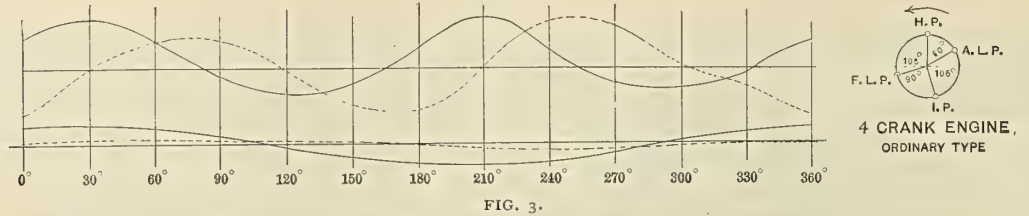
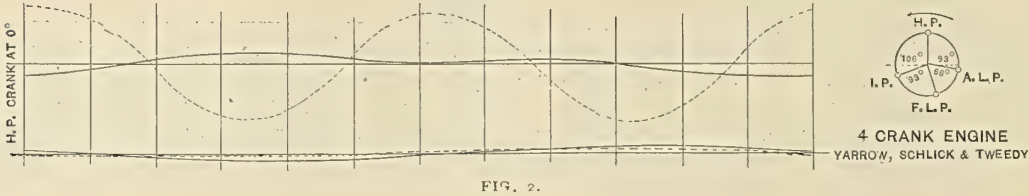
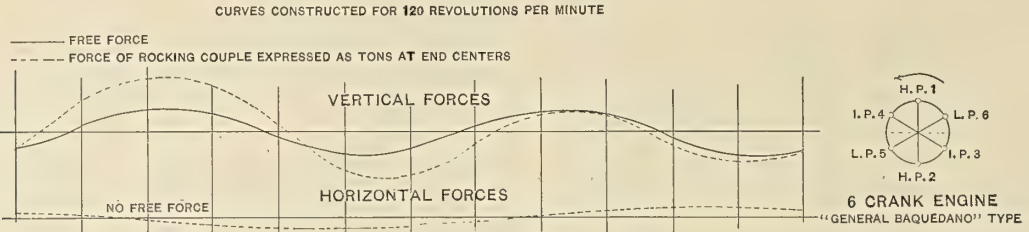


DIAGRAM I.—COMPARATIVE CURVES OF VIBRATION FORCES FOR TWIN-SCREW CRUISER OF 30,000 I. H. P.

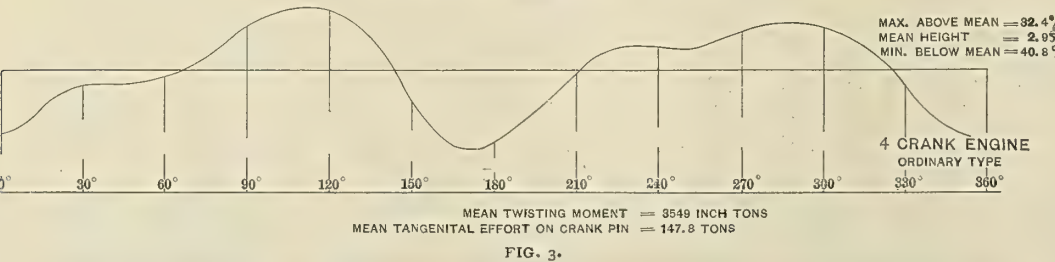
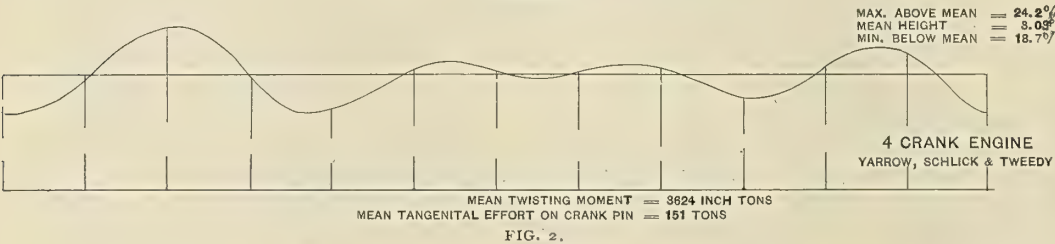
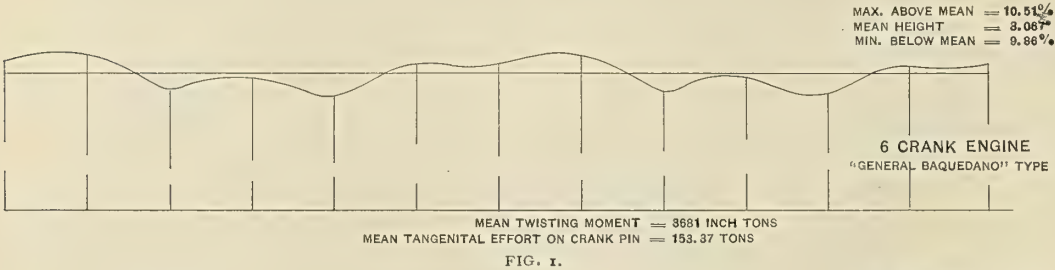


DIAGRAM II.—COMPARATIVE CURVES OF TWISTING MOMENTS OF TWIN-SCREW CRUISER OF 30,000 I. H. P.

arranged as to permit of a limited motion being given to the various parts. The handling of the engines, whether three or six cylinders are at work, is performed with the same ease as in the case of any ordinary triple-expansion three-cylinder engine, one or both engines being worked by the same regulator and reversing engine. It has been previously stated that an independent steam shut-off valve is attached directly to each high-pressure cylinder. In an arrangement of this nature, the piston rods,

connecting rods, &c., and their accessories are duplicates throughout, unless the two engines are designed to develop different powers when working together.

It is advantageous, although not essential, to have a separate condenser and air pump for each low-pressure cylinder; not only is the independence of each

Fig. 1, Diagram III, shows in outline the cylinder tops in the case of the *General Baquedano*, Fig. 2 shows another arrangement, and Fig. 3 still another. The latter is the arrangement adopted in the case of twin-screw engines of 16,500 I.H.P. for the Russian Volunteer Fleet. Messrs. Hawthorn are at present engaged

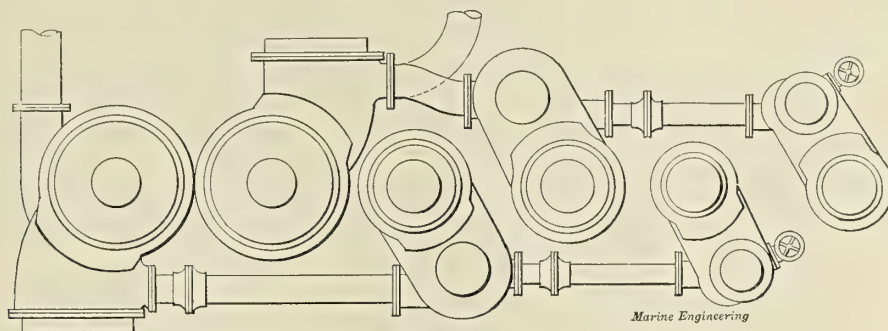


DIAGRAM III.—FIG. 1.

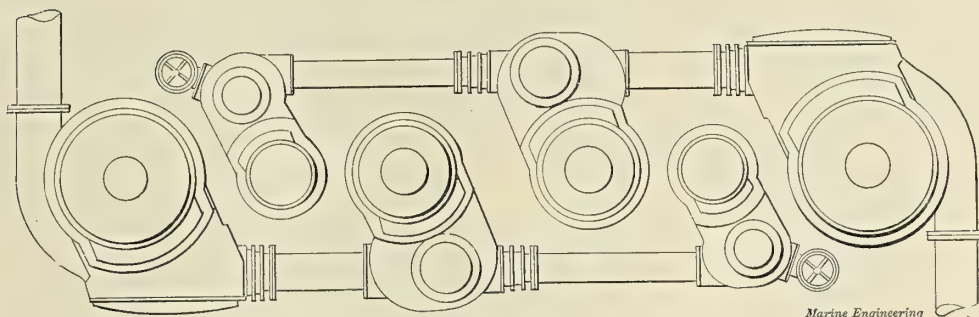


DIAGRAM III.—FIG. 2.

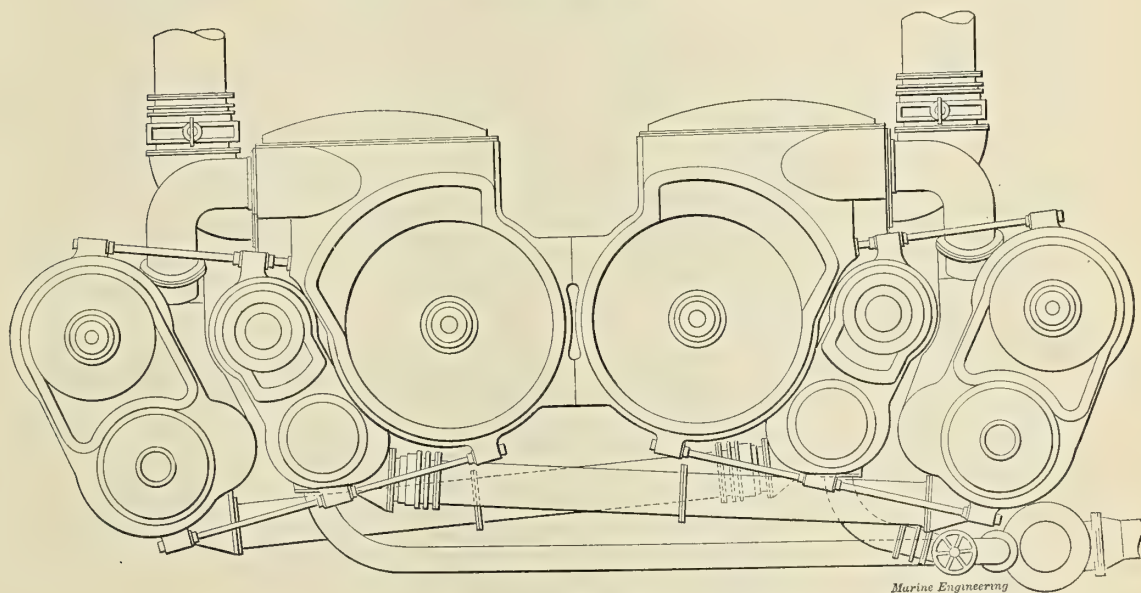


DIAGRAM III.—FIG. 3.

engine thereby more fully maintained, but a greater command over the temperature of the feed water is secured. As a matter of fact, in the *General Baquedano* valves were provided at the request of the Chilian Commission, which enabled each condenser and air pump to be used for either engine.

Alternative arrangements of cylinders are obvious.

in constructing these engines, and we have others in contemplation.

It is manifest that quadruple-expansion engines may be dealt with in a similar manner to that described in this paper, thus forming eight-crank engines.

My firm has recently, with a view to economy, proceeded on somewhat similar lines in connection with

the steering arrangements of some of our large cruisers. These are fitted with two steering engines; but, instead of making these engines duplicates, we have provided different sizes, a large engine for use when the vessel is steaming at the higher speeds, and a small engine of only sufficient size to do the work when the vessel is cruising or steaming with a limited boiler power.

I have endeavored in the foregoing remarks neither to magnify the advantages nor to minimize the disadvantages of the arrangement described.

American Liner Philadelphia.

We present herewith three original photographs of the American liner *Philadelphia*, originally the *City of Paris* of the Inman line, and in more recent times the *Paris* of the American line. These views show in part the present condition of this fine ship, which, it will be recalled, is in dry dock at Belfast, Ireland, undergoing reconstruction after her experiences ashore on the Manacle Rocks off the coast of Cornwall in the English Channel.

It is doubtful if at any previous time any vessel even approaching the size of the *Philadelphia* underwent such a complete overhauling. There have been cases in which practically a new bottom has been worked into a vessel that has had the misfortune to have gone ashore—notably in the case of the P. & O. liner *China*. In this instance, however, not only will the hull below water be largely renewed, but the old machinery will be replaced entirely by engines and boilers of more modern design, and the passenger accommodations will be entirely changed in many important essentials. When the *Philadelphia* resumes her trips in the New York-Southampton trade, she will be a faster and more comfortable ship than the old *Paris*.

Up to the present time the work done on the vessel has been chiefly in the direction of clearing away the damaged and discarded in preparation for the new work. Following the experience gained with the S.S. *Milwaukee* and other vessels, high explosives have been used almost exclusively in removing the plates and structural members which are to be replaced. In this way tons of material have been cut out in mass very expeditiously. While this work has been going on the vessel has been stripped of all her cabin, deck, and engine and boiler room fittings. As the photographs show, the three funnels are gone, and so are the boilers and engines, their substance having been added to the scrap pile some time ago. The photographs do not show the extent of damage which the vessel sustained, as, owing to practical limitations, it was found impossible to get other views. Looking at the vessel from the dock coping, the extent of the injuries are not apparent, and even below the after part of the bottom is not very seriously damaged. Forward of amidships, however, the present condition of the ship is very unusual. The entire bottom has been blown out from side to side, and the interior for a space fore and aft exceeding the beam of the vessel has been gutted, leaving only the deck beams in place, and giving the interior the appearance of an enormous cavern. It was at this point that the

vessel suffered most by contact with the rock-bound Cornish coast.

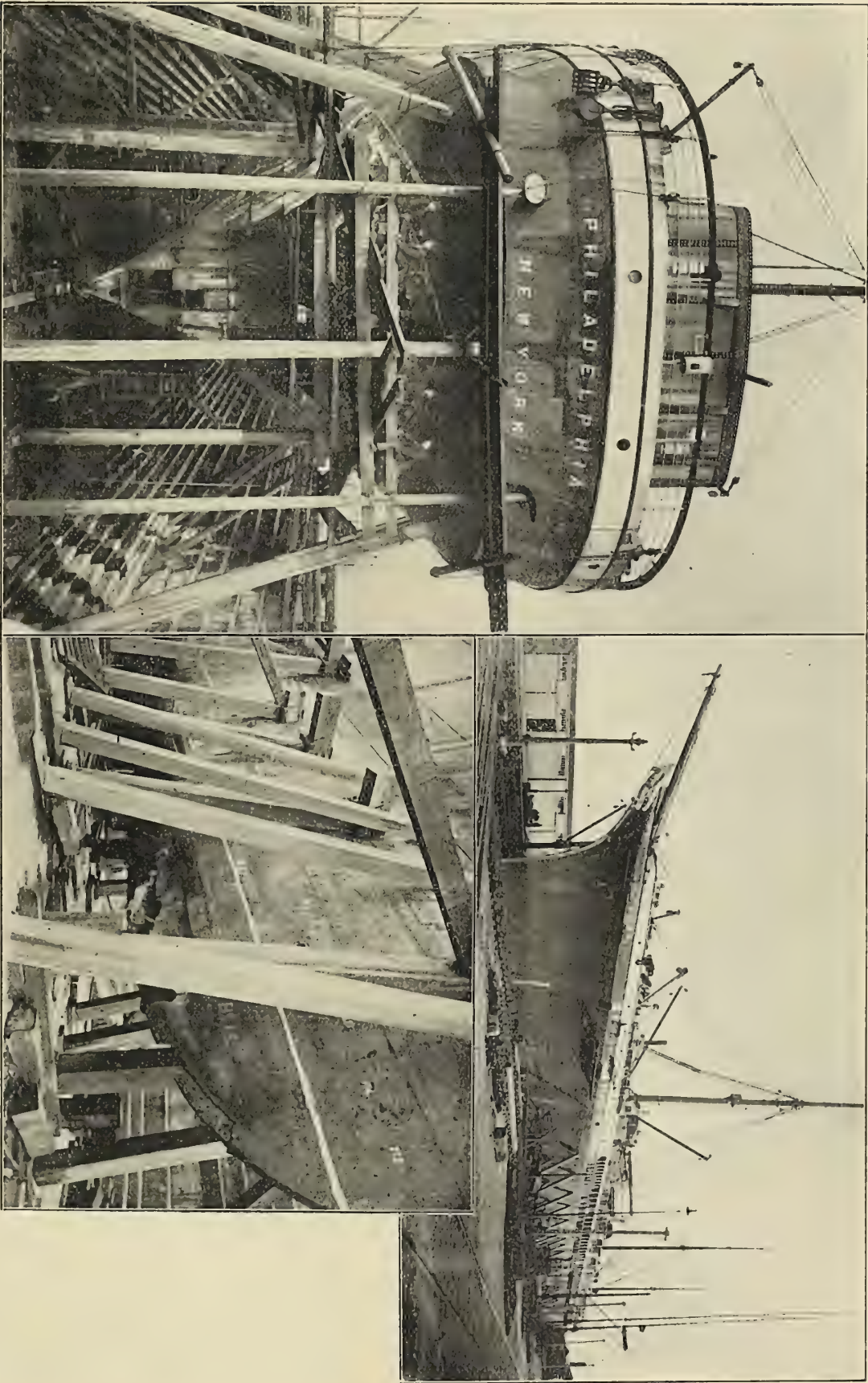
When ready for sea again, the *Philadelphia* will differ from the *Paris* and her sister, the *New York*, in general appearance, in that she will have two funnels instead of the familiar three. Inboard, however, there will be many changes. The inconvenient arrangement of promenade deck on both the *Paris* and *New York* by which the large ventilators block the fore and aft passage way when the passengers' deck chairs are extended, we understand, is to be rearranged, giving a clear, unbroken deck. Changes in construction will also permit of movement in a fore and aft direction on each deck in the cabin passengers' department, without the necessity of going out of doors. Other minor improvements will be made, especially in the arrangement and equipment of the saloon suites of rooms.

In the engineers' department the changes will be greatest. New engines, of the quadruple expansion type, to drive the twin screws, are now under construction in the shops of Harland & Wolff, the contractors for the reconstruction of the liner. These will have cylinders 38 1/2 in., 76 in. and 106 in. dia. and 60 in. stroke. Boilers of the Scotch type will be installed, six double-ended 19 ft. 6 in. long and four single-ended 10 ft. 6 in. long, all of 15 ft. 8 in. dia.

In the hull construction, the only change of importance will be the encasing of the propeller shafts within the hull in the usual Belfast style, instead of carrying the shafts outboard with struts, as on the *Paris* and *New York*.

In carrying out the work, the contractors have a free hand, and it is their intention to give back to the owners a ship which will clip the record of the *Paris* in her best days.

TRANSPORT HARDINGE.—Of late the famous Fairfield yard at Govan on the Clyde has been engaged almost exclusively on naval work. An interesting vessel, however, of the merchant type recently launched at the yard is the troopship *Hardinge* for the government of British India. The dimensions of this vessel are: Length 423 ft. 6 in.; beam 50 ft.; depth to main deck 31 ft.; gross tonnage 5,600 tons. She will be fitted with twin screws, with triple expansion engines having cylinders 29 in., 46 in. and 72 in. dia. and 48 in. stroke. There will be five Scotch boilers constructed for a working pressure of 180 lb. per sq. in. Howden draft will be fitted. There will be accommodations on this transport for about 1,500 persons. The vessel is of the spar deck type and has four complete laid decks; orlop, troop, main and spar deck. This last deck is made with an extensive promenade space, giving room for exercising soldiers. Very special care has been taken in the matter of subdivisions, which, both in the double bottom and hull proper, are numerous and water-tight. Ventilation has also been well considered and a variety of fans installed. There is also an extensive refrigerating plant for supplying cool water and ice and for preserving the food supplies while the vessel is in the tropics. Structural details have been introduced so that the vessel will be able to mount six 4.7 in. and six 3 pounder rapid fire guns and four machine guns. At sea the speed will be about 18 knots.



VIEWS SHOWING THE PRESENT CONDITION OF THE AMERICAN LINER PHILADELPHIA (FORMERLY THE PARIS) UNDERGOING RECONSTRUCTION IN DRY DOCK AT BELFAST, IRELAND.

A YEAR'S EXPERIENCE UNDER THE PROVISIONS OF THE PERSONNEL BILL.*

BY ENGINEER-IN-CHIEF GEO. W. MELVILLE, U. S. N.

In his annual report for 1900 Engineer-in-chief George W. Melville, U. S. N., devotes a special chapter to the consideration of the personnel question in the light of another year's experience under the provisions of the Personnel Bill. In plain language he calls attention to present conditions which manifestly are not helpful to a proper condition of efficiency of our naval vessels. There is, he points out, an entirely insufficient number of officers possessed of sufficient engineering knowledge to exercise intelligent supervision over the engine room staffs of our war vessels. This condition of affairs existed prior to the passage of the Personnel Bill, when the former corps of Naval Engineers performed engineering duties only, and from the report of the Engineer-in-chief, the Personnel Bill as now enforced not only does not afford any relief in this direction, but even intensifies the serious condition which its advocates claimed it would cause to disappear. On account of the importance of the subject we here reproduce the statement of Engineer-in-chief George W. Melville in full:

PERSONNEL.

Another year of experience under the provisions of the "personnel bill" finds the status of steam engineering interests in the Navy even less fully protected, and the number and condition of the force for their control even less satisfactory than when I made my last annual report.

The magnitude of the work under this Bureau has rapidly increased with the additional ships in commission and the new ships building, while there has been a further decrease in the number of skilled officers available for supervising this work and but few signs of speedy replacement.

I am fully aware of the futility and folly of decrying legislation simply because the desired results therefrom do not promptly materialize, but surely time enough has now elapsed since the enactment of the reorganization scheme to make criticism of its effects upon the Navy both proper and important.

To any close observer it is convincingly evident that either the scheme was a mistake, or that the proper course has not been taken to carry out its intent.

I am free to acknowledge that the events of the past year have brought only discouragement to those most deeply interested in a successful outcome of this new law, but I am equally candid in the belief that the cause of this discouragement lies not in the scheme itself, but in a lack of full appreciation, on the part of the Department, of the urgency of the need for haste, not only in providing the fullest opportunity for the acquirement of practical engineering knowledge on the part

of the younger officers of the former line, but in enforcing their embracement of this opportunity in the most effective manner by Department orders. It will not do to depend upon unaided individual enthusiasm or details occasioned by the necessities of particular ships. Such a course merely temporizes with the present needs, fails in any rational degree to increase the force of naval engineers (even should it suffice to replace the annual loss), and is hopelessly ineffective to secure the most desirable results in the shape of a speedy acquirement of general knowledge of engineering on the part of the new line as a whole.

There is an immediate and constantly increasing demand for more expert engineer officers with which to protect the interests of the Government efficiently. This demand can only be met by assigning at once, both ashore and afloat—and in as great numbers as possible consistent with absolutely necessary other duties—the younger line officers as understudies and assistants to the experienced engineers now in charge of engineering work. In no other way can the wished for result be quickly obtained. With a full opportunity provided, I am confident there will be no lack of interest or energetic application on the part of the officers detailed.

In a number of cases former line officers have had charge of the machinery of vessels during the past year, and while, in some instances, owing to lack of experience, their control has not been marked by all desirable efficiency, in no instance has there been evidenced any carelessness or lack of close attention to the work. On the contrary their devotion to the new duty has clearly been indicated.

With steam engineering as a line duty this is pleasing to those who formerly had its entire control, and whose greatest fear might naturally be supposed to be that no efficient engineer officers would succeed them, and that the machinery department of ships would eventually be controlled by men of a more purely practical education (machinist) incapable of maintaining that constant stress toward increased efficiency found so needful to advance or of retaining the proud position of steam engineering of the United States Navy at the head of the marine world.

In my last annual report I endeavored to express the unsatisfactory conditions clearly, but after the lapse of another year a review of these conditions, with additional experience, is necessary.

First, there are available over one hundred less engineer officers than just prior to the personnel act, and at which former time I had good cause to ask for an increase in the full number then on the list.

With this great decrease in numbers came an increase of work, making it a necessity to

*From the 1900 report of the Engineer-in-Chief of the Navy.

curtail the usual and needed allowance of engineer officers for ships until the largest could have but one, and the colliers and smaller ships often none. To the latter were assigned, in most cases, former line officers as heads of the steam engineering department, these depending principally upon the machinists for expert directions. That many casualties have not resulted is not, however, due to the propriety and efficiency of this arrangement, nor does it indicate a safe and commendable condition, for it has only been by dint of the most anxious and continuous care on the part of the depleted force that mishaps and breakdowns have been infrequent. In other words, a state of tension has existed and now exists under which it is neither wise nor safe to continue a day, as it is sapping the energy of good men. Instead of building up a personnel for the day of need, stronger than necessary for the time of peace, the engineer officers and men are kept at the point of elastic limit, and a new war to-day could not fail to develop a large list of physical incapables in the engineering branch the moment the additional burden was put upon them. True, we could call upon the civilian expert for help and no doubt secure many good men, but how foolish to deliberately lean on this uncertainty when it is possible to school our own intelligent and devoted officers to a degree of satisfactory efficiency. That this schooling will eventually be accomplished I still believe; but my earnest request is for a greater effort to hasten it in order that no day of need will find us sadly wanting. I urge you to decided steps toward this object, pointing again to the fact that, at the present rate, new expert engineers are not being made in any rational proportion whatever to the displacement of the old ones from the active list, if indeed they are being made at all.

You are fully cognizant of the intricacy and extent of the engineering department of a large ship. That of a smaller one bears the same importance and carries the same danger for the inexperienced. You can, therefore, judge how impossible it is to create in a few months expert engineers from even the most intelligent officers unused theretofore to machinery. Experience daily under all conditions of service alone perfects efficiency, when combined with intelligence, and it is this experience I ask shall be given to all line officers possible, below the grade of lieutenant-commander, both at sea and ashore. From the many we are sure to gather a fair proportion particularly adapted to the work and with natural proclivities toward mechanics. These will be the real additions to the engineering branch, and will increase as greater numbers come from the Academy. The others, fairly well versed in time, will fill the gaps in emergency or war, and with a universal general interest there will be no need to call for vol-

unteers to man our ships in this department.

Regarding the engineering departments of ships at sea in times of peace as well as war, compare for a moment the condition of a battleship depending for the full and proper operations of her motive power upon the knowledge of a single officer, the chief engineer, with that of another ship of the same class whereon any one of the line officers could, in emergency, take efficient charge of the machinery, and several indeed assume and completely fill the position of an expert in that department. The ideal condition of the latter is what we are now striving for, since engineering knowledge has been recognized as of the most vital importance in the service, and it is to the realization of this I still hopefully look, despite the many visible obstacles.

That I should betray unusual anxiety on this question can only be through my intimate knowledge of the conditions now existing and my earnest interest in the welfare of the service. My views, I can properly say, should have more weight upon this point than the views of any other naval officer or board, as these can not view the situation from as comprehensive a standpoint as can the Engineer-in-chief, upon whose shoulders for years has been the special care and protection of naval engineering.

Inattention to my recommendations or apathy regarding the immediateness of the necessity for more active and decided measures toward securing the desired conditions can surely result in nothing but rapidly decreasing efficiency, from which it will be continually more difficult to recover, and the cost of which will be significant in enormously larger repair bills, shorter-lived machinery, and a fleet of vessels in doubtful fitness for their designed service—a Cervera fleet, with limitless men, but lacking the technical experts needed to meet the extraordinary and ever-new conditions of emergency and war.

I regret I have failed to impress you to the point of action by my former communications. Had a series of calamitous events occurred during the past year to make graphic the insufficiency of the present force of expert engineers, I am sure potent remedial measures would have been promptly taken by the Department. But while glad indeed to have disaster averted, I can assure you that danger now exists. It lurks in the silence of seeming security, but a knowledge of its presence should increase the desire to hasten its removal. Fortune alone has postponed casualty.

The country can safely count on the valor and fidelity of its officers and men, but fidelity and valor without knowledge of the use of the arms given them with which to do battle can avail little against an efficiently drilled foe, and will afford scarcely more than an exhibition of heroic sacrifice, as needless as it would

be cruel. The arms of a battle-ship are her machinery and her guns, "useless each without the other," and strong to victory when working well together. No deep thought is necessary to understand this, in the light of late experiences. The very highest degree of excellence in both the condition and handling of each is the price of successful encounter, or at least is the expectation of the country. A ship motionless or helpless to maneuver well could never make efficient battle, be her guns never so good or her crew never so brave. To guard against this the head of the steam engineering department must be full of resource and armed by experience and engineering ability only attained by years of intimate association with machinery under all conditions of service. Haphazard luck may bring a ship through without this, but sane judgment would condemn dependence on simple fortune, or a failure to use every possible effort to insure a most competent management in this most important of ships' departments.

Engineering work is as full of interest as it is of importance, and the line may well be proud to preserve the control of it. The most intelligent are eager to become experts, and with their superior advantages need no primary instruction. They do need much experience with and observation of machinery at work and under repair or construction and it is for the Department to decide upon the quickest way by which they can obtain this, and then to afford them the fullest opportunities for doing so.

I have already suggested to have incorporated in the regulations the best method for the needed training at sea, i. e., by departmental order to compel all line officers below the navigators of ships to alternate in duty in the engine room and on deck, and efficiency reports to be made quarterly to note their progress and class their ability.

My plea is for the highest efficiency; for immediate recognition of its importance as well as of its present decadence through depletion of the number of technical experts without full provision for early replacement. I hold up the warning finger and sound the note of alarm.

An official utterance on the subject by one of the "old line" officers of equally high rank, from the navigation standpoint, would be of more than passing interest at this time. In the expressive language of the street, it is "up to" the "line" now to make reply.

In a collision off the Delaware Capes, the Old Dominion line S. S. *Hamilton* ran down and sank the coasting schooner A. A. *Shaw*, of Philadelphia, October 7. The steamer hit the schooner amidships, and kept her bow in the opening until the schooner's crew had been hauled up by the ropes. Then the steamer backed out and the *Shaw* went to the bottom. The latter was an old wooden vessel carrying coal.

New York School Ship *St. Mary's*.

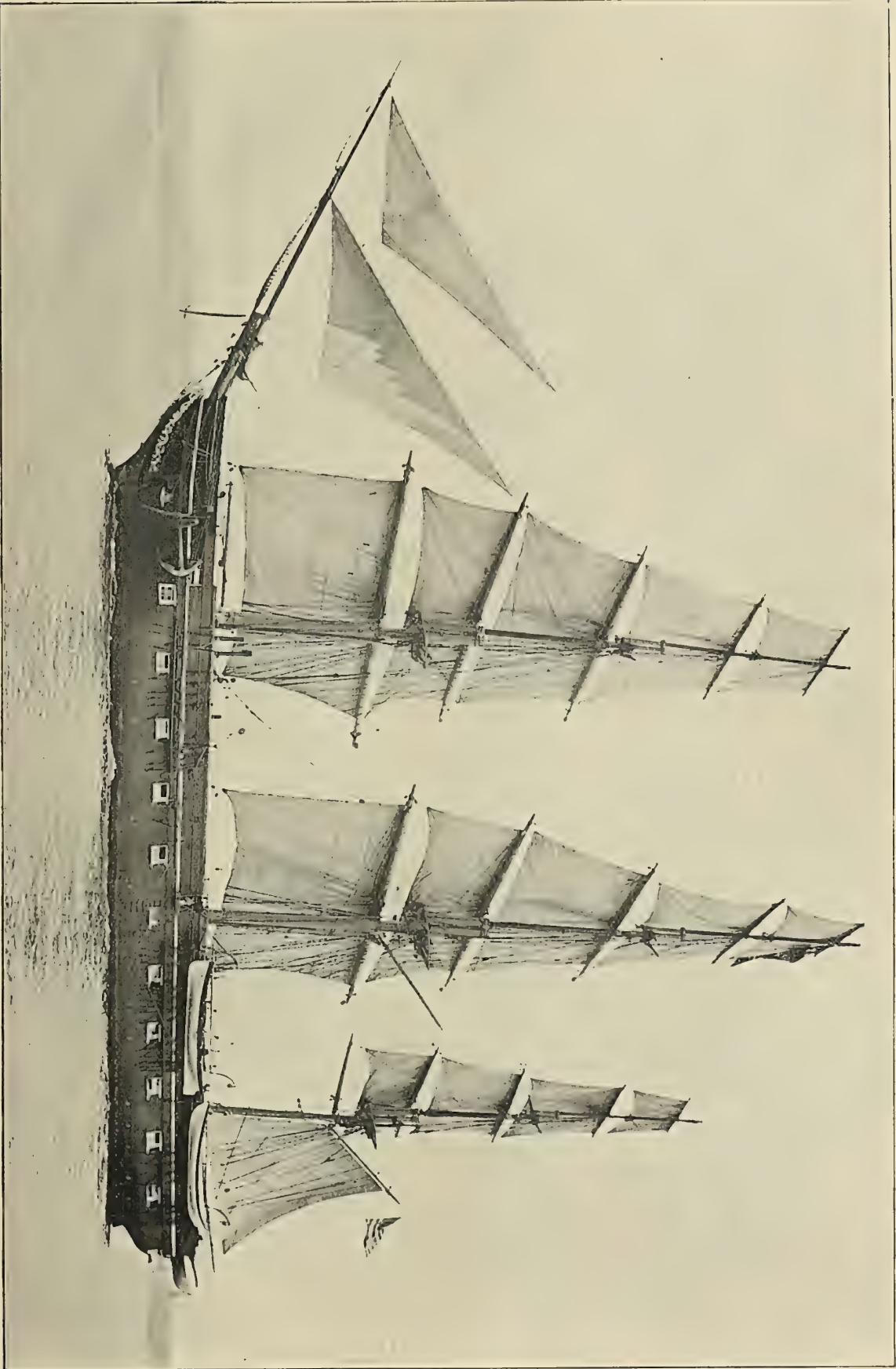
In the photograph of the school ship *St. Mary's*, of the port of New York, is shown the present appearance of a famous old ship of the American Navy. This vessel has lately undergone an extensive overhaul at the New York Navy Yard, and returns to her work of education with a new lease of life. Her construction antedates the Civil War, she having been put into the water at Washington, D. C., Navy Yard as long ago as 1844. She was named for one of the most influential counties in the State of Maryland. The *St. Mary's* is still carried on the roster of naval vessels, being classed as a "wooden sailing vessel." In her day she ranked as a powerful war vessel, her dimensions being: length between perpendiculars, 150 ft.; beam, 37 ft. 6 in.; mean draft, 15 ft. 6 in.; gross tonnage 766 tons, and displacement 1,025 tons.

When built she was fitted with a battery of smooth-bores containing six 8-in. and sixteen 32-pounders, all muzzle loaders. Her first assignment to active duty was during the Mexican war, when she was in Vera Cruz. Later her work was in the Pacific, where she remained throughout the Civil War protecting merchant vessels from Confederate cruisers. It was toward the close of that war that the *St. Mary's*, Captain Colvocoresses in command, saved the port of Valparaiso from bombardment by the Spanish fleet. Her commander placed the ship between the principal city buildings and the Spanish squadron and declined to move when requested to do so by the Spanish admiral.

In the present service of this vessel the mistake is often made of supposing it to be a reformatory for the discipline and moral improvement of bad boys. On the contrary, the vessel is a school ship pure and simple, and very rigid inquiry is made into the character of all applicants for admission. The vessel is officially known as the New York Nautical School, which is conducted by the Board of Education of the City of New York. Candidates must have either a parent or guardian residing in New York, and must be between the ages of 16 and 20 years, of sound constitution, and have shown a disposition to follow the sea. Every candidate has to pass an educational test, and has to provide an outfit, and pay \$25 on admission to cover the cost of uniform and bedding during the course. The course extends over two years, and includes two summer cruises.

When in port the vessel is tied up to dock in the Hudson River, and when on a cruise, the waters of Long Island Sound are usually sailed in until the pupils can easily handle the ship, and then New England ports are visited. On a foreign cruise, the *St. Mary's* calls at English, French and Spanish ports, and touches at the Madeira Islands. At sea, the time of the pupils is given almost entirely to the study and practice of professional branches of seamanship, and while in port, more time is devoted to theoretical work. At the present time many former pupils of the school are actively employed in responsible positions by our great merchant lines, and indeed this school is doing no small share of the work of upholding the American Merchant Marine. Commander W. H. Reeder, U. S. N., is superintendent of the school.

PUBLIC SCHOOLSHIP ST. MARY'S, OF THE PORT OF NEW YORK—A FAMOUS FORMER FIGHTING SHIP, NOW CLASSED AS A WOODEN SAILING VESSEL, OF THE U. S. NAVY.

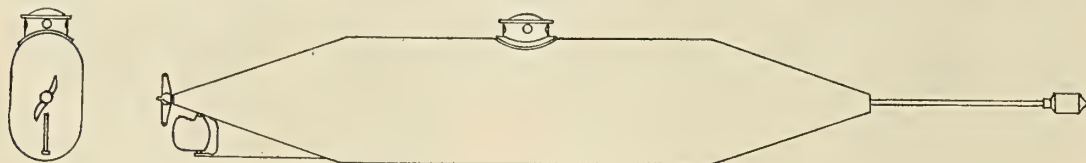


SUBMARINE BOATS—FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.*—II.

BY CARL BUSLEY.

CHAPTER VI.

McClintock's and Howgate's David, 1863.—During the War of the Rebellion, McClintock and Howgate built a submarine boat which was the means of the destruction of the Union sloop *Housatonic*. The shape of this boat can be seen in Figs. 14 and 15. It was about 42 ft. long, and was built of boiler plate. The crew consisted of eight men, of which one man was at the helm, and the other men turned the two bladed propeller by means of cranks. The boat was supposed to have attained a speed of four knots. It has been asserted that the boat could dive to any depth, and remain there a half hour with the whole crew in quiet water, although authentic reports of her trials do not seem to agree with this assertion. The idea of the boat was to tow a mine close under the keel of an anchored vessel, and to explode the mine through contact with the bottom of the ship. Lieut. Paine, of the Confederate Navy, with eight volunteers, undertook to attack the Union vessels. While the boat was being prepared the swell of a passing steamboat splashed into the manhole, sinking her. The eight volunteers were lost, and Lieut. Paine succeeded in getting out, as he was standing at the manhole at the time. After



FIGS. 14 AND 15.—MCCLINTOCK'S AND HOWGATE'S DAVID, 1863.

the boat had been raised, Lieut. Paine made another attempt with eight other volunteers, but the boat ran ashore at Fort Sumter and capsized. On this occasion there were six men lost of the crew, and only the Commander and two men were saved. After the boat was raised for the second time and put into shape, an engineer named Aunley, who had been busy with the reconstruction, attempted a trial trip in Cooper River. While totally submerged his apparatus for getting to the surface must have become deranged as the boat did not rise again, and it was only recovered three days later. The entire crew were, of course, dead. The next trial was undertaken by Lieut. Dixon, of the Twenty-First Volunteer Regiment. He left the harbor with eight volunteers on the 17th of February, 1864, and succeeded in destroying the Union sloop *Housatonic*, which lay at anchor in the outward harbor of Charleston. He had somewhat changed his plans as the attack was not made by means of mines, but was made with a pole torpedo; also the boat was not entirely submerged. During this time the manhole was left open so that the men could breathe more easily. Aboard of the *Housatonic* the boat first gave the appearance of a floating block of wood, and the crew of that vessel only became aware of their

danger when it arrived within about 300 ft. They immediately slipped their anchor and started their engine, and called the crew to the guns, but before a shot could be fired—it was about two minutes after the boat had been sighted—the explosion occurred, and the *Housatonic* sank immediately. Of her crew only five men were killed and the remainder saved themselves by climbing into the rigging which projected above the water. The submarine boat, however, did not succeed as well, as the wave caused by the explosion washed into the open manhole, causing it to sink, and for the last time its entire crew were buried under the waves. The Confederates had lost already thirty-two men by this trial, while the Federals only lost five men, which would not speak very well in favor of the submarine boat. Too much praise, however, cannot be bestowed upon the personal courage and the soldierly spirit of the Confederate volunteers, who were always ready to take the place of the unfortunate crew after the boat's former misfortunes.

CHAPTER VII.

Value of the Pioneer Boats.—All the submarine boats which were propelled by man power were of radically different shapes, and forms, which as a question of standard type cannot be considered at all. They were all of comparative modest dimensions, and on the average did not exceed 50 ft. in length and about 30 tons displacement. Furthermore, their speed of

four knots was so slow that the crew could only expect a successful issue of their attack when those on the attacked vessel were perfectly unaware of their presence. The diving of these boats (omitting the highly problematical Bushnell's diving propeller), was always effected by taking in water ballast, and rising to the surface by ejecting this ballast by means of hand pumps—a very tedious operation, and requiring time. The difficulty in renewing the air supply was mostly avoided by remaining under the surface of the water only for such a length of time as the contained air would permit. The weapon of attack was first the mine and latterly the pole torpedo. The whole arrangement of these boats is of such a nature that very little confidence would be now placed in them, and it is surprising that it was so easy to find crews to operate them in addition to their inventors.

CHAPTER VIII.

Submarine Boats Entirely Submerged, Alstitt's Boat, 1863.—During the war of the Rebellion the submarine boat designed by the American, Alstitt, was a radical change from the former styles, and opened a new era in the construction of submarine boats. In the first place, it was not driven by hand power, but was operated by means of steam and electricity, and its construction, as shown in Fig. 16, was that of a complete small boat of about 75 ft. long and 10 ft. deep.

*Translated from the Proceedings of the German Society of Naval Architects and Marine Engineers, Berlin, Germany.

As long as it sailed on the surface the steam engine was used, but when diving the electric machine was the propelling power, after the fire was drawn from the boiler. The boat had a double bottom, which held the water ballast at both ends, and in the middle held the coal for the boiler. The after part of the engine room was fitted with a cylindrical receptacle for compressed air for the use of the crew when the boat was submerged. At her bow a mine

was attached similar to the style of a pole torpedo. Even if Alstitt did not have an opportunity to develop his ideas, as the boat was not built, it must be conceded that his idea, especially that of the propelling power, corresponds to the present practice.

CHAPTER IX.

Bourgois' and Bruus' Plongeur, 1863.—About the same time that Alstitt designed his craft, Admiral Bourgois and Marine Constructor Bruus were building the submarine boat *Plongeur*, for the French navy, and which was launched at Rochefort in May, 1863. According to Figs. 17, 18, 19, it was about 140 ft. long, 19 ft. wide and 11 ft. deep, and had a displacement of about 450 tons. This displacement exceeds that of the modern torpedo boat destroyers. The six-bladed propeller was driven by an oscillating engine, using compressed air. The

FIGS. 17, 18 AND 19.—BOURGOIS' AND BRUUS' PLONGEUR, 1863.

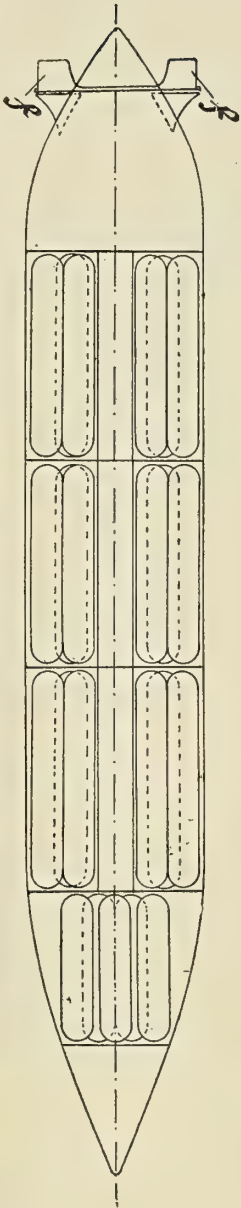
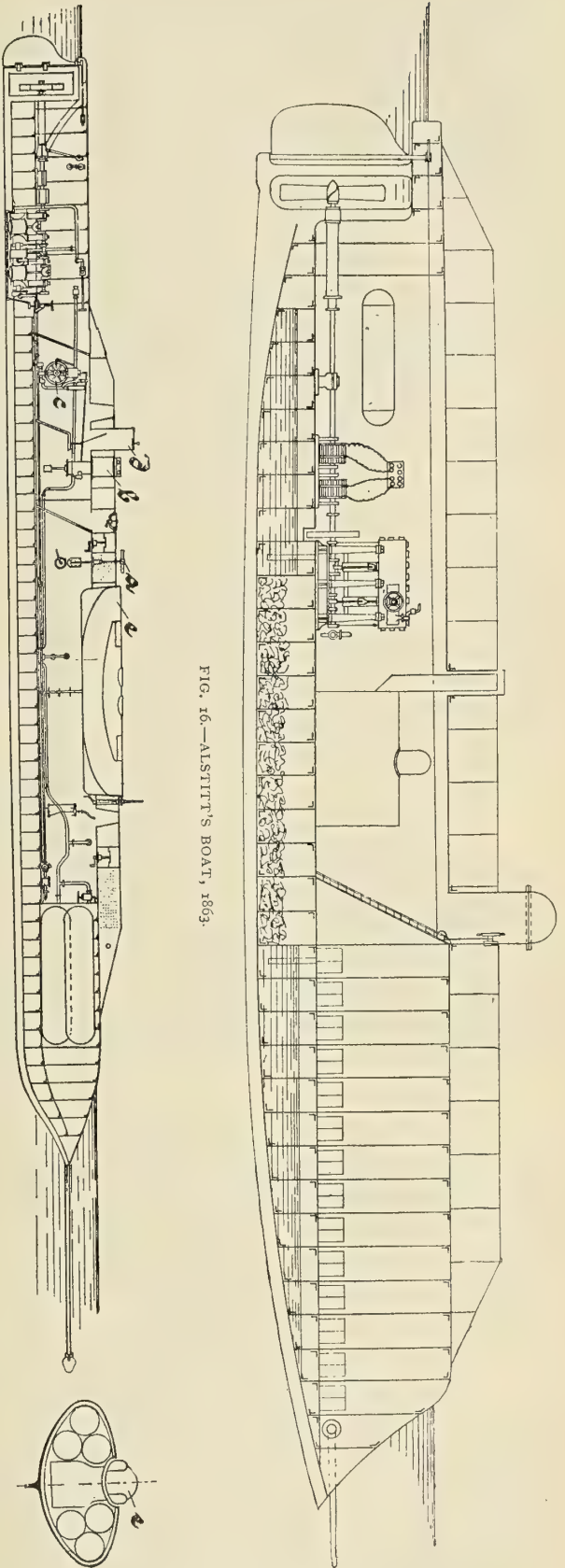


FIG. 16.—ALSTITT'S BOAT, 1863.



compressed air was stored in cylinders as shown in Fig. 19, which occupied the greater part of the ship's body, and were stowed in separate water-tight compartments. The exhaust of this air was used for breathing by the crew while under water. Diving was effected by admitting water into the ballast spaces in the double bottom, and the depth of the dive was regulated by a vertical propeller, *a*, and a cylinder, *b*, with a tight-fitting piston, which increased or diminished the volume of the boat, and in addition the horizontal rudder, *f*. The ballast water was ejected by means of a pump, *c*, also driven by compressed air. The manhole is indicated by *d*, and *e* was a life boat, connected to the body of the larger boat by means of water-tight doors, and which could be readily detached from the ship's body. Her bow was fitted with a pole torpedo. The boat made a number of trials in the harbor basin at Rochefort, and also at La Pealisse, and it was demonstrated that when she was completely submerged, she lost her fore and aft stability, owing to her great length, as when she was sailing in a submerged condition she was either bumping the bottom or coming to the surface. For this reason she was placed out of commission in 1864 and broken up.

CHAPTER X.

Vogel's Boat, 1868.—During the years 1867-72, Vogel, of Dresden, had worked on the plans of a submarine boat, shown in Fig. 20, and did not succeed in getting beyond the first trial. The boat was built at the former Schlick's yard, in Dresden, in the year 1868. Her dimensions were: Length, about 16 ft.; depth, 4 ft. Her construction consisted of T iron frames and

of the hand pump, *m*. Vogel intended to use a torpedo as his weapon, but did not state how it was to be carried or operated. He predicted that his boat would be able to remain submerged for three hours. According to correspondence which he had with the German navy up to the year 1872, it appears that he did not make a successful submerged trip in the river Elbe, as intended.

CHAPTER XI.

Drzewiecki's Boat, 1884.—The Russian engineer, Drzewiecki, in the year 1877, built a small submarine boat about 13 ft. long, driven by means of a propeller. As the boat had accommodations for only one man, this propeller was worked by means of a treadle, combined with a tooth-wheel gear. Both sides of the dome in which the man stood were fitted with leather gloves to enable the operator to attach mines to the vessels which were to be attacked. In 1879 Drzewiecki designed in St. Petersburg a somewhat larger boat, about 20 ft. long and of sufficient capacity to hold four men and the commander. The diving outfit consisted of the usual water bottom, with means for letting in the water or pumping out the same. When the boat was in motion it was canted by means of two weights, to enable it to sail to the surface or to get beneath the surface. These weights were attached to chains, so that the middle weight would move forward at the same time that the after-weight moved towards the middle, when it was required to dive to a greater depth. When it was required to come up the forward weight was moved to the middle, and the other weight was moved aft. Drzewiecki attached a tube fitted with

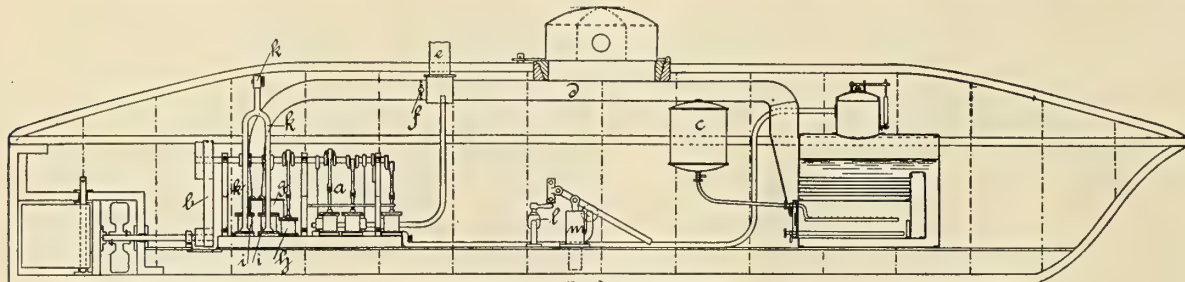


FIG. 20. VOGEL'S BOAT, 1868.

iron shell. Her propelling power consisted of a three-cylinder steam engine, *a*, which drove the propeller by means of belts, *b*. When floating on the surface the engine worked high pressure, and when submerged it worked with a condenser. Steam was generated by means of oil fuel. Oil was stored in the receptacle, *c*, and ran by gravity into a burner which, as shown in Fig. 21, consisted of a perforated copper pipe. The gases of combustion were discharged into the chimney, *e*, when floating on the surface, and when underneath the water were discharged into the receptacle, *g*, in which the temperature was reduced by means of a spray of water, which was forced into it by the pump, *h*. For the separation of the soot the coal gases were to be ejected clear of the boat by means of two air pumps, *i* and *j*, directly attached to the engine through the discharge pipes, *k*. In order to dive, the double bottom was filled by means of a cock, *l*, and to come to the surface the water was ejected by means

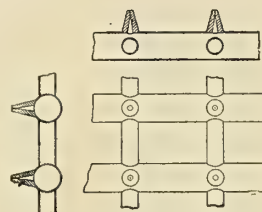


FIG. 21. OIL BURNER, VOGEL'S BOAT.

prisms in order to be able to see objects above the surface. Finally, in 1884, he designed a submarine boat, as shown in Fig. 22, in which the propeller was driven by means of dynamos and accumulators. The two moving weights of his first boat were replaced by a single one, and, as the figure shows, this weight could be moved by means of a chain from one end of the boat to the other, and it was guided in a tube

in the ballast space. It was reported at one time that the Russian Navy was going to build fifty-two of these boats as equipment for their battleships, but this evidently must have been only the hope of the inventor, as nothing further was heard in the matter.

CHAPTER XII.

Tuck's Peacemaker, 1886.—In 1884 an American, Professor Tuck, made experiments with a submarine

called the *Peacemaker* (Figs. 23 and 24), with a length of 30 ft.; 8 1-4 ft. beam, and 5 1-2 ft. deep. It was propelled by a 14 horse-power Westinghouse steam engine, and with 350 revolutions, the boat is supposed to have attained a speed of 8 knots, not beneath the water, as has generally been reported, but floating on the surface. In order to stiffen her light construction she was fitted with a fin keel on top, with a de-

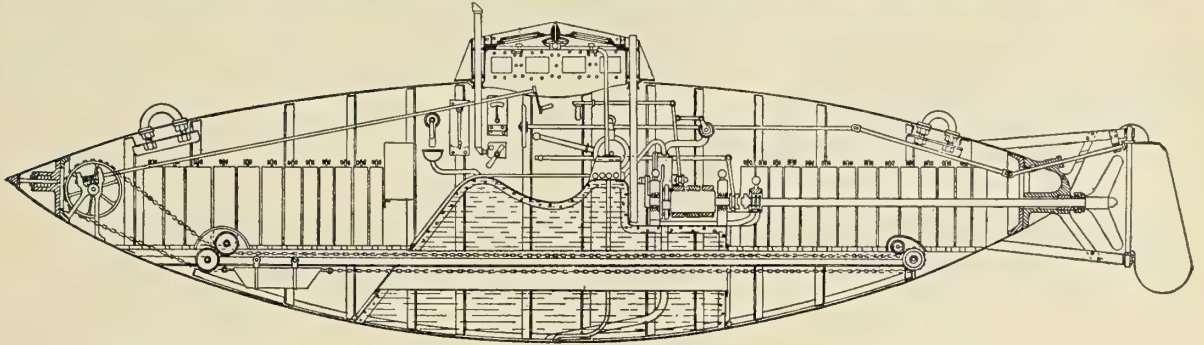
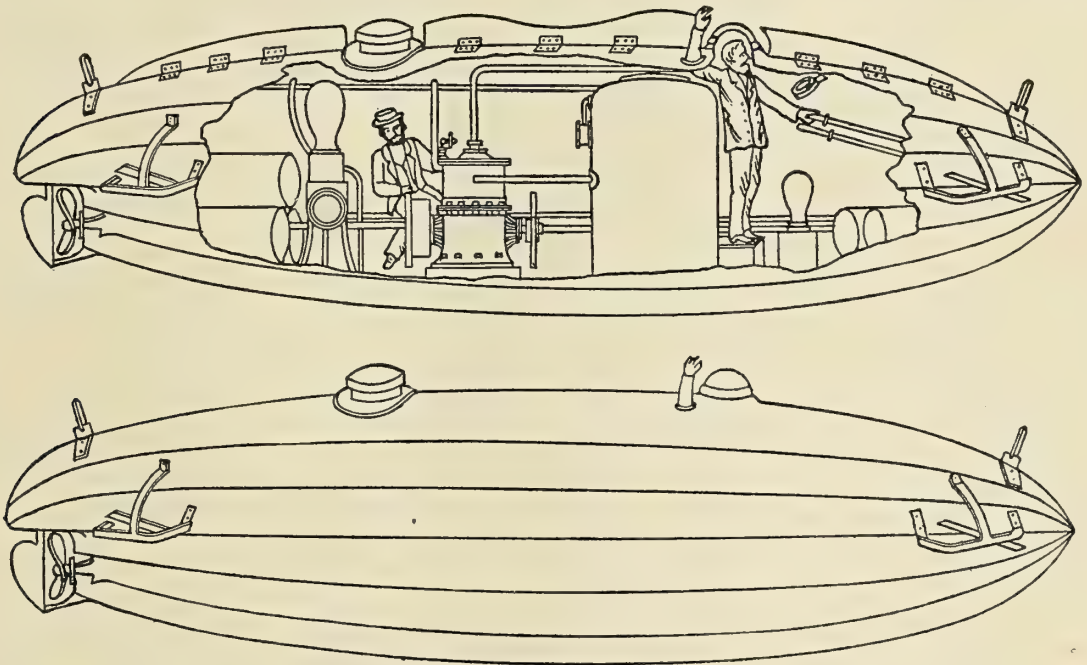


FIG. 22.—DRZEWIECKI'S BOAT, 1884.

boat, with a length of 30 ft. and of 10 tons displacement. This craft was driven by means of storage batteries, and was said to have attained a speed of 6 knots. It was fitted with two Fish torpedoes, which were attached to the boat by means of electro-magnetic claws. The latter could be operated from the inside of the boat in such

pression in the middle, the latter being intended to give her a better hold under the keel of a vessel. On either side of the dome, as well as at both ends, water-tight gloves were fitted to facilitate the placing of the torpedoes, which, in this case, as well as in the first Tuck's boat, were carried on the sides. It has been reported that the *Peacemaker* remained at a depth of



FIGS. 23 AND 24.—TUCK'S PEACEMAKER, 1886.

manner that the torpedoes could be released at any moment. The boat had one bad feature; the outfit for renewing the air consisted of two pieces of hose, each terminating in a float which rested on the surface of the water. Fulton had tried the same thing, and Tuck had the same misfortunes that his predecessor encountered. In 1886 Tuck built a second boat,

53 ft. for a period of 7 minutes. Another time she is said to have steered a course under water in which she sailed under two vessels, and at still another time, to have dived under a tugboat without having been observed by the crew of the tug. In spite of all these so-called successful trials, the *Peacemaker* has never been pronounced a permanent success.

TORPEDO CRAFT (UNITED STATES AND FOREIGN) TYPES AND EMPLOYMENT.*—III.

BY LIEUT. R. H. JACKSON, U. S. N.

In order to have present practice abroad in a readily available form, the following table has been arranged, which is fairly accurate, the conflicting statements of

well to bear in mind that some of the boats do not in practice carry both torpedoes and guns; one or the other is left ashore.

A liberal allowance of coal and water must be carried, remembering that at night the boats must be actually cruising. During the day, by running slow under one engine, and carefully tending the two large

Nation.	Type.	Built.	Building.	Displacement.	Length.	I. H. P.	Speed.	Armament.
England.....	Destr.	108	10	300	210	6,000	30	1 12-pdr., 5 6-pdr. 2 T.
	Boats	98	..	....	....	....	..	.....
France.....	Destr.	4	8	300	185	4,800	26	1 9-pdr., 6 3-pdr. 2 T.
	Boats	211	8	152	144	4,200	30	2 3-pdr. 2 T.
Russia.....	Destr.	1	28	240-350	196	3,800	27	3 1-pdr.
	Boats	174	17	120	....	....	..	.....
Germany.....	Destr.	1	5	350	210	5,800	28	5 3-pdr 3 T.
	Boats	113	9	155	157	2,500	25	1 R. F., 1 mch. 2 T.
Italy.....	Destr.	....	8	320-350	196-208	6,000	30	1 12-pdr., 3-5 6-pdr. 2 T.
	Boats	142	2	150	156	2,700	25	2 1-pdr. 2 T.
Japan.....	Destr.	....	8	275-300	220	6,000	30	1 12-pdr., 5 6-pdr. 2 T.
	Boats	44	12	130	148	2,000	26	2 3-pdr.
U. S.....	Destr.	....	16	420	245	8,000	29	2 12-pdr., 5 6-pdr. 2 T.
	Boats	20	11	165	175	3,000	26	3 3-pdr. 3 T.

the different sources of information upon this subject making it very difficult to obtain correct data.

REQUIREMENTS OF DESTROYERS.

Speed.—The boat must have sufficient speed to overhaul a torpedo boat and disable her. It is well to remember that at night the discovery will be made at close range, and but a slight superiority in speed will be sufficient to enable the destroyer to close sufficiently to prevent the boat from eluding her, and enable the gun captain to hit his indistinct and difficult target. The flare from the stack of the fleeing boat, when she is pressed to her limit of speed, will materially assist the destroyer unless the rain, snow, or fog intervenes. In daylight the discovery of the torpedo boat is not likely to be made at more than five or six miles, so that a difference in speed of three knots would give the destroyer the necessary superiority. A speed of 28 knots that can be maintained for six hours is sufficient for all purposes, and gives a surer indication of the value of the boat than a delusive 32 knots with bottled-up steam over the measured mile. To attain this result the machinery must not be shaved too light. The results of the performance of some of these boats abroad during the last years indicate that the factor of safety is too small, and that the number of revolutions allowed is beyond safe practice, making the strain on the moving parts tremendous; any slight flaw in forging or tempering, and the engine-room is a wreck—if there is no worse result. Let us not be carried away by the desire for the fastest boat in the world. Moderate revolutions and steam pressure and staunch machinery, and we can challenge the speeds shown in the table, and feel that we have the better boat.

Armament.—Five 6-pdrs., one 12-pdr., two tubes, and two torpedoes.

The argument in favor of this battery is found under the head of Criticisms on Ordnance.

From the table it is seen that our armament is still the equal of any nation, and superior to most, except in the number of torpedoes carried on board. It is

distilling plants that are needed, she can replenish her water supply. In case of necessity, coal and water can be supplied from the big ships, such as the *New York*, and the distiller ship; but it is best to be self-supporting, as weather and unusual circumstances may make assistance impossible.

Displacement.—Before deciding upon the size it is well to bear in mind the two distinct rôles in which the destroyer appears.

First.—She is a terror to all torpedo boats; her powerful battery, relatively high speed in all weathers, and shallow draft, leave them but little hope for escape, unless a lucky shot at long range disable her. In this rôle she acts as the night policeman for the fleet, easing the nerves of the battleship.

Secondly.—and this is a point that is likely to be forgotten—she is a terror to the enemy's fleet; for not only does she carry the same torpedoes, and will appear from more distant points, but she still retains that essential element to successful attack by surprise, a relatively small size and consequent invisibility. It is the failure to recognize this essential quality that has led to the advancement of a type of boat of 600-800 tons displacement, which is based on the sound doctrine "the bigger the better," when coal endurance, stanchness, comfort, and speed are the qualities desired. The "low, long, rakish, craft," this invisible terror of the seas, must be retained, as in the piratical days of old, to destroy a few and strike consternation to the hearts of all.

We have reached the happy result, but the outside limit, in our 420-ton destroyer. It is well to remember that foreign practice tried this 800-ton boat several years ago, in their "avisos" and scouts, which were afterward abandoned, and then developed the torpedo boat to its present size. By examination of the table it will be seen that even now we lead all other powers in the displacement adopted.

TORPEDO BOATS, CLASS P.

Requirements.—Only sufficient speed is needed in vessels of this class to make it possible to overhaul and attack a distant fleet cruising at a moderate speed.

*Prize essay read before the U. S. Naval Institute, Annapolis, Md., and copyright, 1900, by R. H. Jackson, U. S. Naval Institute.

Twenty knots is thought to be a good sustained speed for an all night run in moderate weather. This would give a 25-knot speed for the dash to escape after the attack. A boat that can be relied upon to do this should be able to maintain a speed of 25 knots for six hours in smooth water.

A flotilla of these boats would temporarily accompany the squadron till the commander-in-chief decided upon the point of attack, or received information of the enemy which would permit a blow from this mobile arm of his fleet. After the attack the flotilla would probably return to the nearest base. They are expected to join the fleet whenever needed, and to remain till the attack has been pressed home. But the admiral would leave them resting on a convenient base till the time seemed ripe for the blow.

The armament thought best is three S. A. 6-pdrs., two tubes, and two torpedoes. The reason for this selection is found under Criticisms on Ordnance.

Displacement.—The displacement must be kept as small as is consistent with sea-going power. These boats must be able to keep with the squadron in all weather; and have a crew, coal, and water, sufficient to be counted on for a week, and still be able to return to port. The *Porter* seems to have been able to fulfill these conditions under the test of war; yet no smaller boat seemed to be able to come up to this requirement, so that 165 tons seems to reach the sea-keeping power combined with a size that permits of a successful surprise in a night attack. Great Britain alone has recognized that boats of a smaller type than this fail to attain this sea-keeping requirement. She reported adversely upon her largest torpedo boats in 1896, and since then has built nothing smaller than the destroyer. The table shows that France and Germany are trying 150-ton boats, their first venture in boats of such great displacement, France, alone, with her desire for the marvelous, stipulating a speed of thirty knots. Twenty-five knots maintained speed answers all requirements. The table shows that for our 165-ton boat, the armament is superior to that of any boat abroad; but three 6-pdrs. would make her a Tartar for destroyers and small gunboats.

STATION BOATS, CLASS Q.

There does not seem to be any need for this class in the scheme for coast defense, and they are not sufficiently powerful for offense. So that though the ten that we have thus far acquired are quite useful for drills and exercises in our home ports, and will make good station boats for the West Indies, there seems to be no reason for duplicating any of the six types represented by the ten boats in this class.

As for the *Manley*, no one seems to know for what she was designed or why she was bought. Possibly, it was to give us wrinkles in design and construction. This was a reason that I heard advanced for the purchase of the *Somers*. This boat, 150 tons, has but a single screw, and when the attempt was made to bring her over she leaked so badly as to require her return to port. After the war she was brought over in a freight steamer. She has the lines typical of all the Elbing boats. She carries an underwater bow tube, which may have been the cause of her trouble. At any rate, Germany has lost three boats by foundering at sea,

and it is thought that they were on these lines, though smaller. In the latest sea-going German boats there is no submerged bow tube and no forward conning tower.

STATION BOAT, CLASS R.

As already stated, twenty boats of the *Talbot* type, with a 1-pdr. forward and a machine gun aft, would cover the conditions for the defense of the waterways and harbors.

Having decided upon our general type, let us examine the details of construction, equipment, &c., on board our boats to see if they have stood the best test of their value, viz., satisfactory results on boats in commission. This examination will be taken up according to the classification by departments on board ship. The writer is encouraged to make this minute and detailed examination by the generous desire shown by the bureaus concerned to make the changes suggested, and remedy the faults where a remedy could be pointed out.

DETAILED CRITICISM AND COMPARISON OF CERTAIN POINTS IN CONSTRUCTION.

In no way is the difference between an experienced builder and the novice so evident as in the details of hull construction, and its fittings, and in the use of some little device learned by experience, which often adds materially to the efficiency and comfort of the boat.

Consequently, the writer does not believe that any detail is too trifling to criticise, especially if a remedy is easily found. A striking example will first be given to illustrate the point, before going into an enumeration of details.

A large ventilator was placed over a cabin in order to give fresh air to the sleeper. The result was a wet bunk all the time; at sea it was salt water; in port, rain or sweat from the plate on the inside. In practice the bottom of this ventilator was kept tightly closed by a plate, and the canvas hood placed on the outside when going to sea.

Ventilators.—Experience would indicate that all attempts to ventilate compartments by means of small ventilators are failures. The discomforts and damage inflicted by salt water and rain more than offset the possible advantage of these few small air pipes. The only exception to this is for the compartment containing the closets, where there is usually little to spoil by salt water.

With this exception, there should be no opening in the deck from one end of the boat to the other except hatches and coal bunker scuttles. The hatches should be arranged with some device allowing them to remain open and yet keep out rain and spray, even though occasional seas sweep on board.

On one of the boats of the *Winslow* type, canvas hoods were fitted over the hatches of the principal compartments (i. e., the living spaces and the engine rooms), which were lashed around the hatch coaming and carried up about two feet, and the opening left on the lee side. These were only put on in bad weather. An excellent device is found on some boats. The hatch hood is a quadrant of a cylindrical section, one side fitting over the hatch, and the other open to the air, ordinarily looking forward. The upper half

of the periphery opens or closes by a sliding shutter. Shutters, either sliding or swinging, can also be fitted to the side that looks forward.

The advantages of this arrangement are that: (1) In fair weather the sliding top can always remain open unless the sea would enter a hatch with 18-in. coaming; (2) in falling weather, by hauling over the sliding shutter on top, and shifting hood so that the side opening looks to leeward, no water will enter. In ordinarily good weather, with sliding shutter on top hauled back and side shutter open, entry and exit are in no wise impeded. With an ordinary cowl the hatch can not be used for this purpose. This hood of course having a rectangular base, has only four positions, abeam, and fore and aft; but its efficiency seemed little reduced thereby; while its usefulness in all weather recommends it greatly. They should undoubtedly be fitted to each living compartment, and seem to be equally adaptable as hoods for blower engines in fire-rooms. When fitted over blowers they should have light wire screens, say a 2-in. mesh, to prevent signal flags and wash clothes from going into the blower.

Each living space should have two openings, to facilitate exit and also to give proper ventilation. For the two principal spaces, the cabin and the crew's space, the conning tower can be utilized for one of these, and a hatch, as above described, for the other. If an old-fashioned wind sail is then rigged in the hatch or tower, as best serves, a good supply of air will be insured in these two compartments in practically any weather, a condition that has often been denied our boats. A scant supply of air at 115 degrees, and that mixed with salt water, will lay low the toughest mariner, and result in a short time in a disabled crew and boat. Few of the boats during the war, when subject to these conditions, could boast of a man who had not been seasick.

The air ports on the sides abreast the living quarters are very convenient, and, when reasonable care is taken to renew the gaskets when softened by heat or oil, are satisfactory.

Referring again to the ordinary round top cowl or hood, an objection to it was noticed which may be new. When a man is feeling his way along the deck at night in rough weather and has seized the rim of the cowl, instead of getting support from it, the cowl, revolving from his weight, has sent him stumbling against the rail with the roll of the boat; on one occasion the cowl came off and the man was with difficulty saved from going overboard.

Clear Decks.—While on this subject of ventilation and deck opening, too much stress can not be laid upon the necessity for clear decks. There should be no openings in the decks except for the blowers, the passage of men below, the coal scuttles, and a large hatch over each engine. All these, when closed, should offer an easy gangway for travel fore and aft. Especially should this be true of the coal scuttles and engine room hatches. A satisfactory scuttle, flush with the deck and reasonably tight when cared for, is a rectangular brass plate held down by dogs against a rubber gasket fitted in a score around scuttle. A passage along the decks of some of our boats on a dark night is at the imminent risk of going over-

board, to say nothing of the condition of shins which is sure to exist as a result.

Deck Covering.—After a good deal of experimenting on the suitable covering for the deck, the choice now seem to lie between linoleum and grating. The most satisfactory result has been obtained by laying gratings along the line of traffic fore and aft, and holding them down by movable cleats, so that they can be taken up without much trouble, and yet will not wash overboard in a sea-way. In case of abandoning the boat these are useful as life rafts, as they can be loosened in a moment.

The only advantage possessed by linoleum over gratings is a reduction in weight, and this is not great; its disadvantages are: (1) Lack of durability, being easily punched full of holes and torn around the edges; (2) difficulty of securing it to the deck, as on any other than flat deck boats the first sea will catch under a loose edge and rip up a whole sheet. It then requires a dry, warm day to stick it down. Also, if water lodges under it, the deck will rust badly. Then, over the fire room, the different coefficient of expansion of the linoleum and steel will always loosen those sheets.

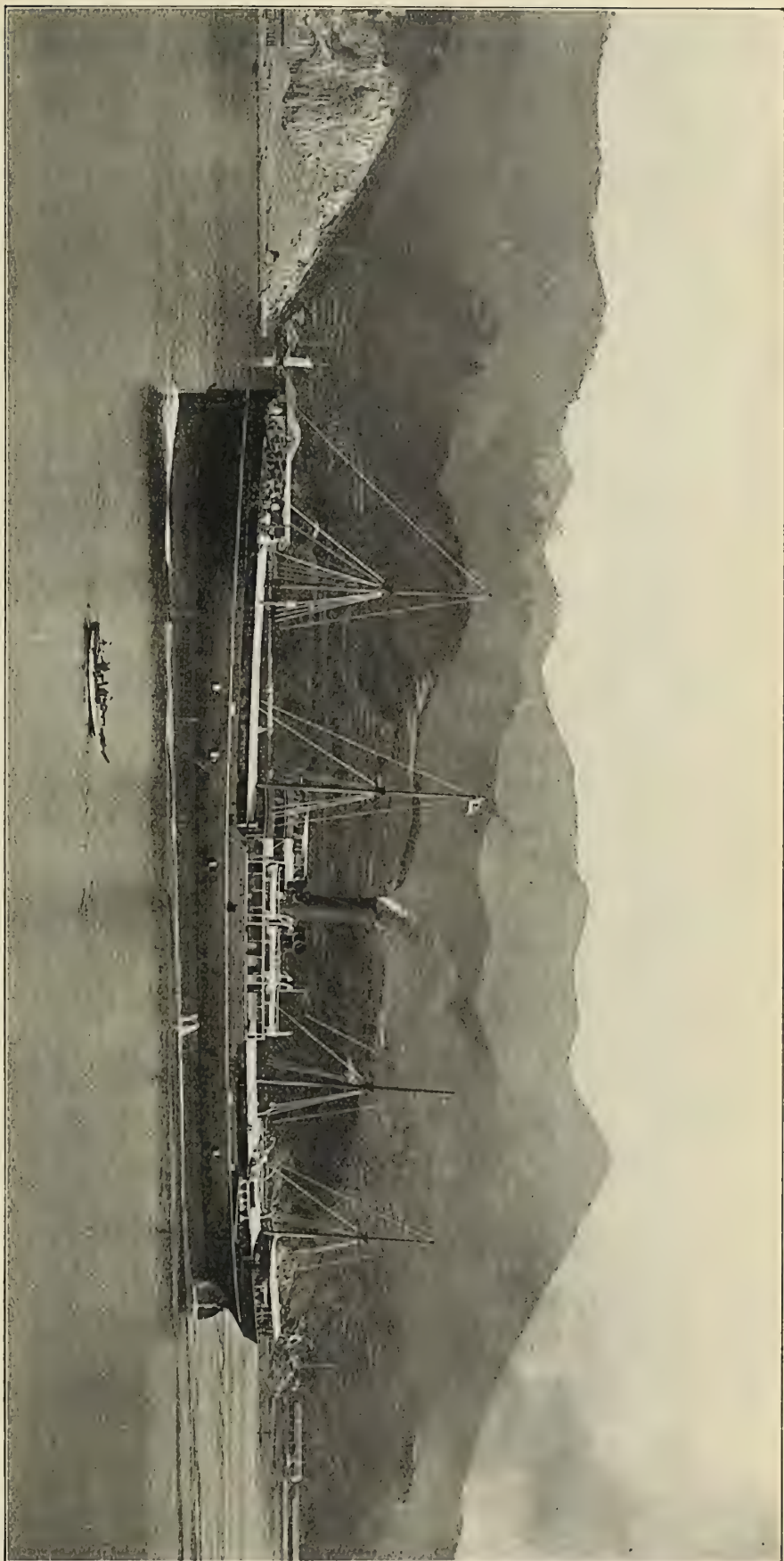
Linoleum has been satisfactorily used as follows:

On the *Talbot* class by holding the strips over boiler-room down by 1-4 in. strips of steel along the edge secured through the deck by round head stove bolts. This system could be applied throughout, using galvanized iron or brass strips on the edge of each sheet of linoleum and holding it down with screws through the deck.

On the *Winslow*, which type, being turtle-back, have given the most trouble, a sort of combination of grating and linoleum has been adopted. Wooden strips, 3 in. wide and 3 in. apart, run fore and aft, held down by screws; under these wooden battens are linoleum strips. The arrangement prevents slipping, but as the foot finds no complete support either on the battens or between them, it would soon become disagreeable and tiresome when one moves about the deck. Rubber matting, which has been tried on some boats, is not only soon broken to pieces but is actually heavier than the grating.

NEW S.Y. ALVINA.—The new steam yacht building at the yard of Harlan & Hollingsworth, Wilmington, Del., for Charles Fletcher will be christened *Alvina*. She is of these dimensions: Length over all, 255 ft.; length on water line, 178 ft.; beam, 26 ft. 8 in.; draft, 11 ft. 6 in. The yacht will be schooner-rigged, and will be fitted with a long continuous deck-house, with pilot-house and captain's room on top at the forward end. The machinery will consist of two sets of triple expansion engines of about 1,300 collective horse power. Boilers will be two in number, of the Scotch type, and there will be bunker capacity for 170 tons of coal. Her trial speed is placed at 14 knots.

Upon the representations of several shipbuilders, the date for the opening of the contracts for the new battleships has been postponed from November 15 until December 7 next. This will give intending bidders an opportunity to submit figures on their own designs.



S. S. HITACHI MARU, 6,172 G. T., LEAVING NAGASAKI HARBOR ON HER MAIDEN TRIP—FIRST LARGE STEEL MERCHANT VESSEL BUILT IN JAPAN.

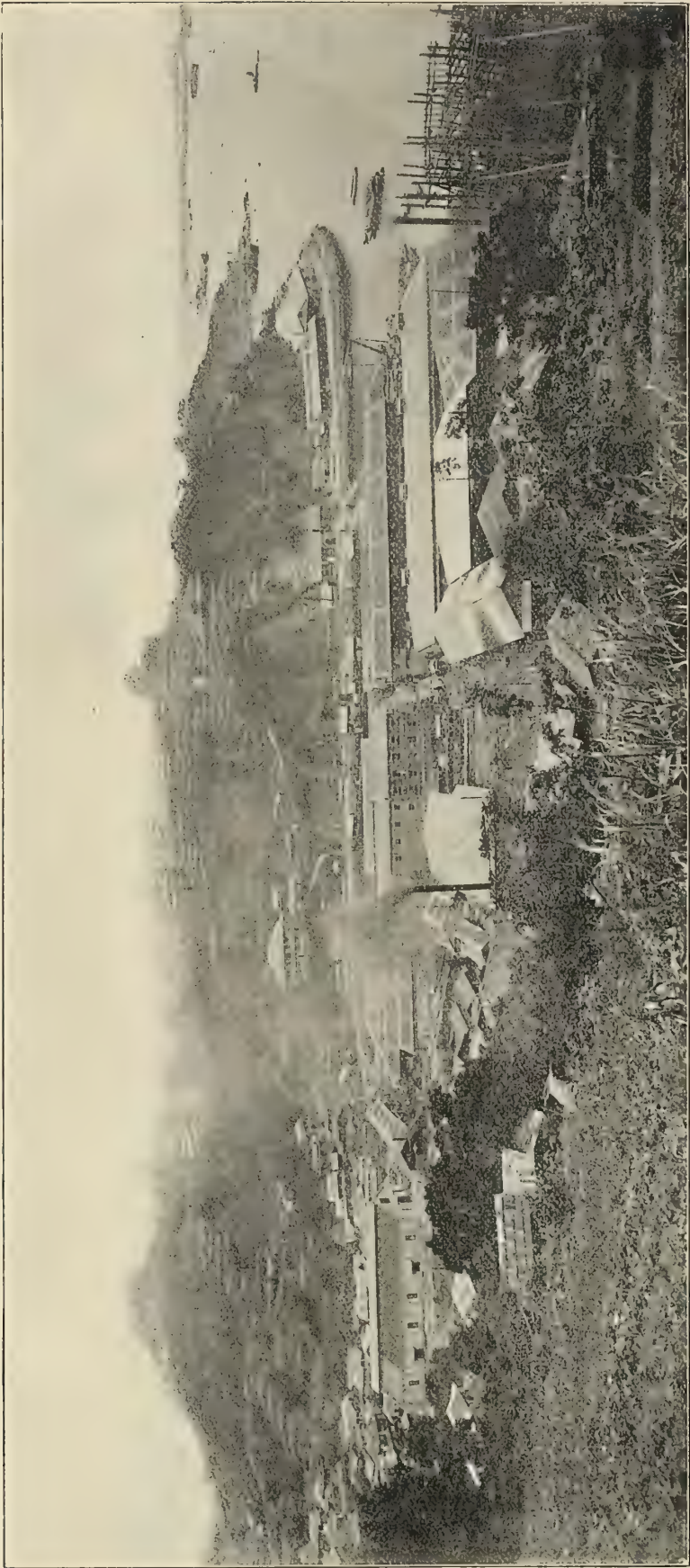
PROGRESS IN MODERN STEEL SHIP AND ENGINE BUILDING IN JAPAN.

In keeping with progress in other branches of applied science the Japanese have gone ahead in the matter of steel shipbuilding at a surprising rate. The principal yard is located at Nagasaki and is known as the Mitsui Bishi Dockyard and Engine

Works. It is controlled by the Mitsui Bishi Company, of Tokyo, which is owned by the family of Baron Iwasaki. This shipbuilding concern was originally established by Dutch owners in 1860, and in 1884 it passed into the hands of the present owners. Iron shipbuilding was commenced five years later.

In 1898 the first large merchant steamship built in Japan was turned out in these works. This was the

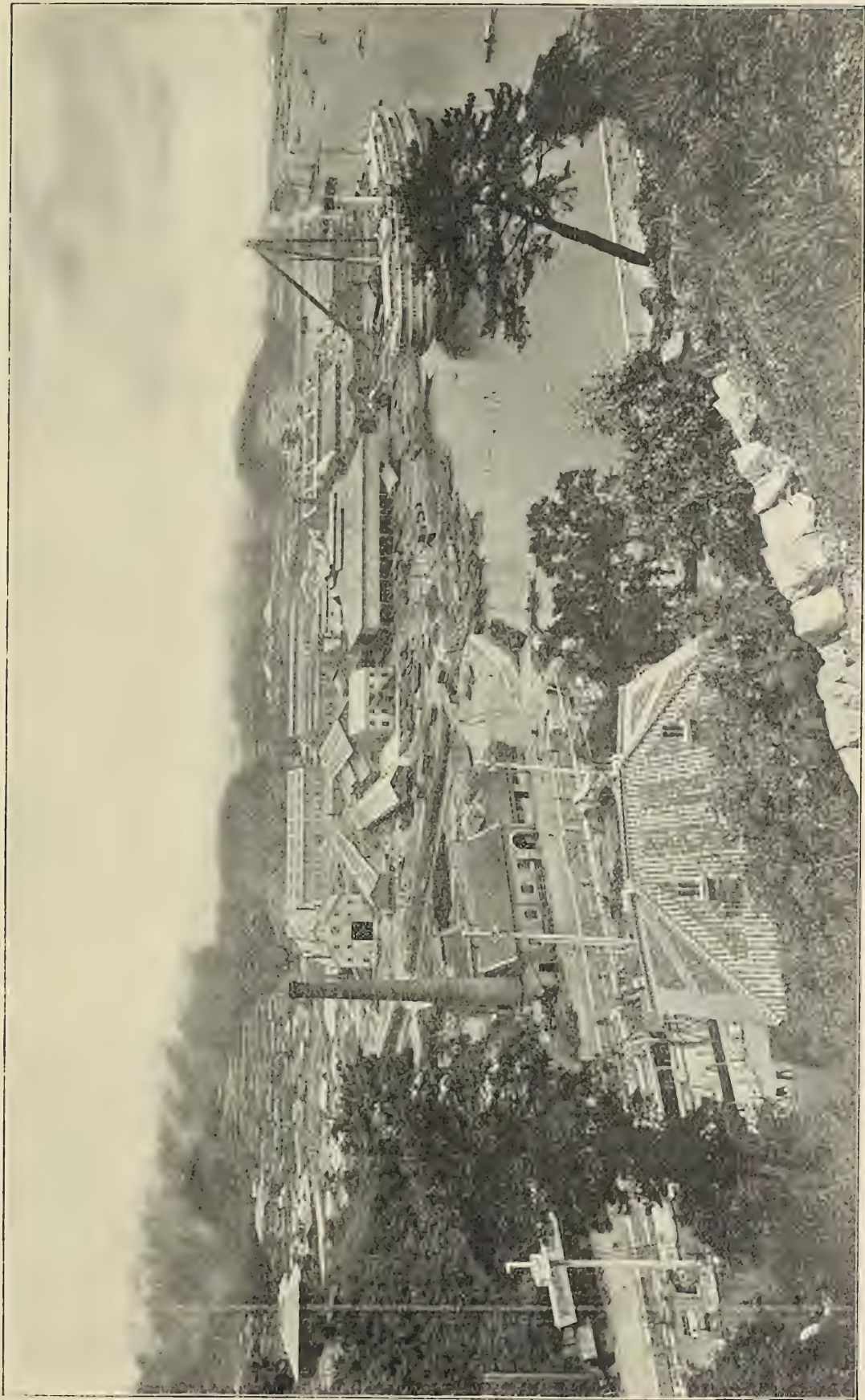
Hitachi Maru, 6,172 gross tons, built for the Nippon Yusen Kaisha (Japan Steamship Co.) and classed 100 A1 in Lloyd's Registry. In the accompanying engraving the *Hitachi Maru* is shown steaming out of Nagasaki harbor on her maiden voyage. An idea of her dimensions can be had by comparing her size with that of the native boat in the foreground. Since that time very great improvements have been made in the establishment, and not only



GENERAL VIEW OF SHOPS AND NO. 1 GRAVING DOCK IN THE SHIPYARD OF THE, MITSU BISHI WORKS IN NAGASAKI HARBOR, JAPAN.

Name of Vessel.	Hull.	Kind of Vessel.	Length.	Breadth.	Depth.	Tonnage.	I. H. P.
Tsukishima Maru.....	steel	sailing s. screw	238 ft.	38 ft. 6 in.	24 ft. 3 in.	1,519	395
Hitachi Maru.....	steel	steam tw. screw	445 ft.	49 ft. 2 in.	{ 23 ft. 6 in. } { 25 ft. 6 in. }	6,172	3,888
Tategami Maru.....	steel	steam tw. screw	300 ft.	40 ft.	21 ft.	2,691	1,550
Toyora Maru.....	steel	steam tw. screw	130 ft.	23 ft.	9 ft. 3 in.	322	346
Bikan Maru.....	steel	steam tw. screw	135 ft.	23 ft.	9 ft. 3 in.	320	329
Awa Maru.....	steel	steam tw. screw	445 ft.	49 ft. 2 in.	{ 23 ft. 6 in. } { 25 ft. 6 in. }	6,309	4,112
Akanoura Maru.....	steel	steam tw. screw	260 ft.	37 ft.	19 ft.	1,717	1,340

LIST OF STEEL VESSELS CONSTRUCTED BY THE MITSU BISHI DOCKYARD AND ENGINE WORKS.



GENERAL VIEW OF THE ENGINE SHOPS OF THE MITSUBISHI DOCKYARD AND ENGINE WORKS AT KANAGAWA, NAGASAKI HARBOR- NO. 2 GRAVING DOCK IN FOREGROUND, AND U. S. HOSPITAL SHIP RELIEF LYING AT THE SHEER LEGS.

has the capacity of the yard been largely increased, but by the introduction of new tools and appliances the finest grades of work can now be successfully undertaken.

In the accompanying reproductions of photographs on pages 474, 475, the shipyard and engine works are shown. The harbor of Nagasaki is of great natural beauty, and is well adapted for purposes of marine construction, and its position geographically makes it a convenient port of call for ships engaged in the trade in the Far East, where workshops are few and far apart. The steel vessels built at the yard and delivered complete to the owners up to this date are enumerated in the table on page 474.

In addition to this new construction the yard erected three torpedo boats for the Japanese Navy and three bucket dredges, the materials for which were imported from Europe. They have also finished a number of steam launches and new machinery and boilers for various steam vessels.

In connection with the works there are two stone drydocks respectively 523 ft. and 371 ft. long by 99 ft. and 66 ft. wide, with 27 ft. 6 in. and 24 ft. 6 in. over the sills at springtide. There is also a marine railway which will lift up 1,200 tons. In the shipyard there are four main building berths as follows: One 600 ft., one 460 ft., one 350 ft. and one 300 ft.

Vessels at present under construction in the yard include:

Name of Vessel.	Hull.	Kind of Vessel.	Length.	Breadth.	Depth.	Tonnage.	I. H. P.
No. 121.....	steel	steam tw. screw	270 ft.	40 ft.	12 ft. 6 in.	2,221	1,800
No. 122.....	steel	steam s. screw	175 ft.	33 ft.	12 ft. 6 in.	581	400
No. 123.....	steel	steam tw. screw	445 ft.	49 ft. 2 in.	33 ft. 6 in.	6,240	5,000
No. 125.....	steel	steam tw. screw	445 ft.	49 ft. 2 in.	33 ft. 6 in.	6,240	5,000
No. 126.....	steel	steam s. screw	186 ft.	29 ft.	16 ft. 2 in.	710	520
No. 131.....	steel	steam s. screw	320 ft.	42 ft.	25 ft.	2,660	1,550
No. 132.....	steel	steam tw. screw	270 ft.	40 ft.	12 ft.	2,389	1,850

In addition to the new work a very extensive business in docking and repairing is carried on.

In two years 435 vessels were handled, distributed thus:

	Japanese Navy.	Japanese Merchant Vessels.	Foreign War Vessels.	Foreign Merchant Vessels.	Total.
From Oct., 1897, to Sept., 1898.....	15	104	31	42	192
From Oct., 1898, to Sept., 1899.....	20	84	32	104	243

Among the recent additions to the equipment of the works are an overhead traveling hydraulic crane in the erecting shop of 30 tons capacity, a tripod shear legs of 100 tons capacity on the jetty, and a 105-ton boiler riveting machine. The blacksmith shop has been reconstructed and is now able to undertake any necessary forge work, having several steam hammers, including one of 7 tons. In the foundry the capacity is 50 tons. This shop has two overhead traveling cranes, one of 30 tons capacity and the other of 20 tons, and there are also five 5-ton swing cranes in the wing.

Recently a decision was reached to substitute the electric drive for the present methods in the shops, and plans have been made for the installation of two powerful generating sets in the engine works, and two smaller ones in the shipyard. A pneumatic plant will also be installed, though for the present to a limited extent.

Both the yards and the shops are lighted with electric light. In the ship and engine works the average number of employees is 3,500, and for the benefit of these the management conducts a school for apprentices, a hospital, and a water works. Salvage operations are also carried on by the concern. A large plant is now available for wrecking work, and one of the steam vessels now under construction, No. 126, is being built as an addition to the present facilities.

Much of the credit for the forward condition of the dock-yard is due to James S. Clark, the resident naval architect. Mr. Clark has had a wide experience on the Clyde and elsewhere, in both merchant and naval work, and has displayed conspicuous ability in an administrative capacity in his work in Japan.

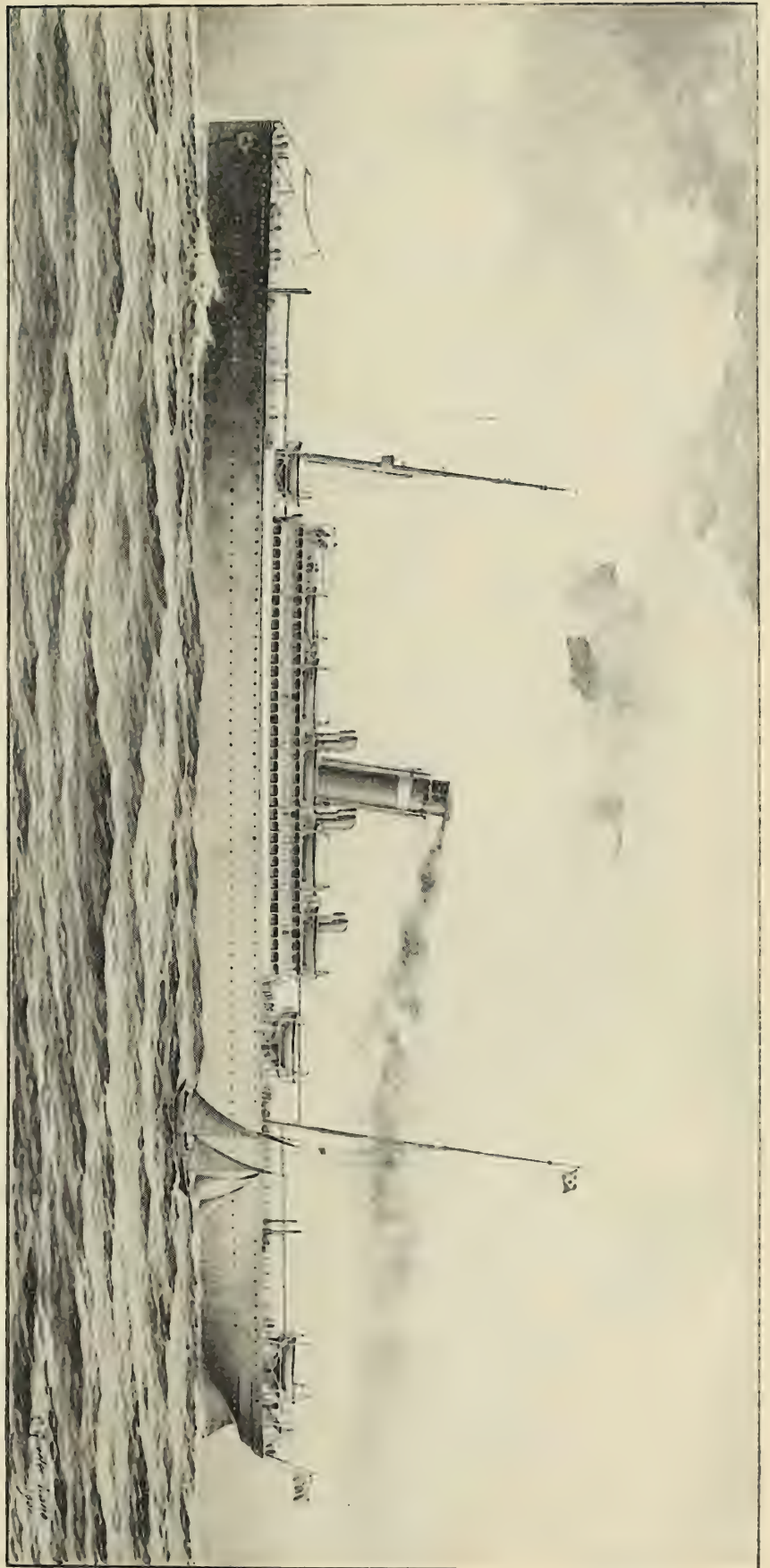
Transatlantic Liner Commonwealth.

Another fine steamship for the Boston-Liverpool trade has just been put into transatlantic service. This is the T. S. S. *Commonwealth* of the Dominion Line, shown in the accompanying artist's sketch. In general design the new vessel follows the popular *New England* of the same line, though she is of larger dimensions, being nearly 600 ft. long and of 12,000 tons, gross tonnage. She was built at the yard of Harland & Wolff, Belfast, Ireland, and follows their

model for transatlantic vessels of the intermediate class.

Although intended to carry an immense amount of freight, the passenger accommodations have not been

slighted. The saloon is situated in a deckhouse erected on the hurricane deck, with seating accommodation for about 200, and surmounted by a very elaborate dome skylight in handsome stained glass, with decorated panels. On the saloon deck, which has a large and spacious promenade, easy seats have been arranged for the passengers, and on this deck is the deckhouse containing the handsome entrance to the saloon, lounge and ladies' room, and library, tastefully decorated in polished woods, with bookcase and writing desks. The ladies' room and lounge, as in the *New England*, is fitted immediately forward of the library, and beautifully upholstered in moquette, with stained glass windows into the saloon dome and on to the deck. The majority of the state rooms are in the same house as the saloons, the baths and lavatories being arranged at the after end. On the deck below there is a comfortably arranged second-class



DOMINION LINE T.S.S. COMMONWEALTH, 12,000 G. T., BUILT BY HARLAND & WOLFE AND RECENTLY PUT IN SERVICE BETWEEN BOSTON AND LIVERPOOL, CARRYING PASSENGERS AND FREIGHT.

saloon capable of seating over 100, and on this deck there are also a large number of first and second-class state rooms, together with engineers' quarters, lavatories, pantries, galleys, and other accommodation. On the middle deck there are also state rooms for first-class passengers forward, and second-class passengers aft, arranged conveniently to their respective saloons. Aft in the ship is a well-arranged closed steerage, with large deck accommodation for

passengers and also a smoking room on the poop deck. Steerage rooms are arranged on the upper deck in the starboard alleyways. The captain's room and chart room are situated on the boat deck, with pilot house above, and a commodious smoking room has been provided with the door opening on to the saloon deck, and also a stairway to the lower deck for convenience in getting to the cabin accommodation in bad weather. A large smoking room and

ladies' room have been arranged for the second-class passengers on the bridge immediately above their saloon.

All modern appliances for the lighting, heating and ventilation of the ship, and for the preservation of perishable cargo and stores have been installed. The propelling machinery consists of two sets of quadruple expansion engines of the builders' usual design.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

WE here present the programme for the eighth general meeting of the Society of Naval Architects and Marine Engineers, which will be held in Engineering headquarters, 12 West Thirty-first street, New York city, on Thursday and Friday, November 15 and 16.

THURSDAY, NOVEMBER 15, 1900.

1. Capacity Test of a Unique Form of Air Pump. By F. Meriam Wheeler, Member.
2. Interchangeability of Units for Marine Work. By W. D. Forbes, Member.
3. The United States Experimental Model Basin. By Naval Constructor D. W. Taylor, U. S. N., Member.
4. The Composition and Classification of Paints and Varnishes. By Prof. A. H. Sabin.
5. Tests of the Electric Plants of the Battleships *Kearsarge* and *Kentucky*. By Naval Constructor J. J. Woodward, U. S. N., Member.
6. Coaling of the U. S. S. *Massachusetts* at Sea. By Spencer Miller, Associate.

FRIDAY, NOVEMBER 16, 1900.

7. Notes on Recent Improvements in Foreign Shipbuilding Plants. By Ass't Naval Constructor H. G. Gillmor, U. S. N., Member.

8. Can the American Shipbuilder under Present Conditions Compete with the British and German Shipbuilders in the Production of the Largest Class of Ocean Passenger and Freight Steamships. By Geo. W. Dickie, Member of the Council.
9. Classification Rules. By Theodore Lucas, Member.
10. Recent Designs of Battleships and Cruisers for the U. S. Navy. By Chief Constructor Philip Hichborn, U. S. N., Vice-President.
11. A Comparison of the Contract Prices of Our Naval Vessels. By Harrison S. Taft, Associate.
12. Launch of a Cruiser and a Battleship. By James Dickie, Member.
13. The Safety of Torpedo-Boats at Sea and in Action Under Various Conditions. By Naval Constructor Lloyd Bankson, U. S. N., Member.

Members who intend to propose candidates for admission to membership in the society can now obtain the necessary forms of application by addressing Secretary-Treasurer Francis T. Bowles at the headquarters. It is desirable that all applications should be in the hands of the secretary not later than Tuesday, November 13, for presentation to the council, which meets on the following day at 3 o'clock in the afternoon.

WHAT is the limit to size and speed of an ocean liner in the transatlantic trade? This is a question that has occasioned much theorizing in times past, and will probably continue to occupy attention so long as the art of steam navigation is practiced. At various times in the past many engineers believed that the question had been settled practically. It would have been settled long ago, had engineering science come to a standstill, and had the commercial possibilities of the age ceased of development. Apparently we are now as far removed from finality as when the old *Alaska* came into port under six days, and held the position among all merchant fleets that the *Deutschland* holds to-day. However, no sooner have the *Kaiser Wilhelm der Grosse* and the *Deutschland* broken all existing records for ocean going vessels than an announcement of a still larger and faster ship is made. This vessel has been ordered by the North German Lloyd line from the Vulcan Works at Stettin, and she is to be named the *Kron Prinz Wilhelm*. At the same time the same line has ordered from the Vulcan Works, also, another marine monster, which, though not in-

tended to be in the front rank in speed, will be so in point of size and equipment. This vessel, the *Kaiser Wilhelm der Zweite*, will be more than 700 feet long and of proportionate beam and depth, rivaling the now famous *Oceanic* in dimensions. Yet another and larger vessel is to be built for the Hamburg-American line by Harland & Wolff, builders of the *Oceanic*. The new liner will be 750 ft. long and about 76 ft. beam, and will have, according to authoritative statements, a speed of 18 knots. Meanwhile advices from abroad report a stirring up in British shipping circles and the intention, credited to the Cunard line, of making an effort to bring back the speed record to the British flag. In the background, as an unknown quantity is the steam turbine, which may or may not work still greater changes in the transatlantic trade than have been recorded in the past twenty years. This very problem, the application of the turbine to large vessels, is at present absorbing the attention of persons of skill on both sides of the Atlantic. In any event, in this contest for speed, starting from a common point, limitations are reached in the direction of finance more quickly than in the direction of practical engineering. Yet though these limitations are opposite, they have a certain relationship which complicates the question presented to the steamship manager for solution. Given an almost wasteful expenditure from an engineering standpoint, we get an increase in income which, though it may not be proportional to the extra expenditure involved, will be vastly greater than would result from a more moderate investment. Compare the passenger rates of two boats like, for example, the *City of Rome* and the *Deutschland*. One will carry a passenger across the Atlantic just as comfortably as the other—though of course, less luxuriously in the case of the older vessel—and the extra time spent on the water in the case of the smaller vessel is not a matter of real consequence to the average tourist. It is the go-ahead spirit of the time that enters here. Passengers who can afford it, and many who cannot, believe in traveling on the fastest, newest, and most up-to-date ship they can find, and are willing to back up their belief by paying the enormously greater fares. Travelers of this type will always exist in sufficient numbers to fill the sailing list of the record breaker in season. Each of these travelers becomes a missionary for the company, if his expectations are realized, and thus helps to create that sentiment in favor of a line which

managers find profitable. And in the case of lines with a reputation to make, it is worth a considerable expenditure to create such a sentiment. There is, to our notion, a more serious limitation than cost, and that is safety. As ships, passenger ships, grow larger, their crews increase in number and the passenger list grows to huge proportions. Yet beyond additions to the number of boats carried, there is no progress in the direction of providing for the safety of those on board in case of extreme peril. Below there may be induced draft and quadruple expansion in the engineer's department, grand pianos and gymnasiums in the passengers' department, but above deck there are the same old boats and davits that hung along the sides in the days when the box boiler was supreme and every cabin passenger was practically his own steward. Water-tight compartments are good "talking points." Something besides compartments, however, was needed on the *Elbe*, *La Bourgogne*, the *Mohegan*, or even on *H. M. S. Victoria*, and that something had no existence in fact. What man of experience at sea would care to contemplate standing on the deck of a modern liner, which was going from under his feet, in company with considerably more than a thousand persons, men, women, and children, in a majority of whom the fierce instinct of self-preservation had taken control. It may be said, truthfully, that a small vessel would sink as quickly as a large one, under like conditions, and that therefore there is no greater danger on the modern monster than on the old liner. It is equally true, however, that the larger the crowd to be handled, the more difficulty there will be in getting results, even though the crew and boats carried are in proportion. Panic is fed by numbers, and every additional passenger is an additional care, not only physically but mentally and morally; an increase of the diversity of opinion and interest that is the antithesis of discipline and co-operation in time of disaster. Disaster cannot be prevented by ignoring its probability. In matters of actual construction vast sums are spent experimentally, but for investigation into the best method of preserving the lives of those carried, not one cent is available. If transatlantic companies can combine to maintain rates, surely they could combine to investigate the subject of the safety of those who pay the rates? They cannot perform their plain duty by waiting until some inventor devises a plan which they can then adopt.

IMPROVED APPARATUS.

Sectional Fire Tube Boiler.

The Cowley & Cooper boiler is designed for use in naval and merchant vessels of large power and under continuous steaming for long periods. By ref-

at their front and back ends by wrought steel necks, thus forming a unit, as shown in Fig. 1. Each unit is connected at its upper and front end by four 4 in. tubes to a steam drum, which affords separating surface and steam space for the rising currents from each unit. Neck pieces of wrought steel connect each unit at its lower and back end with a mud drum. Two to

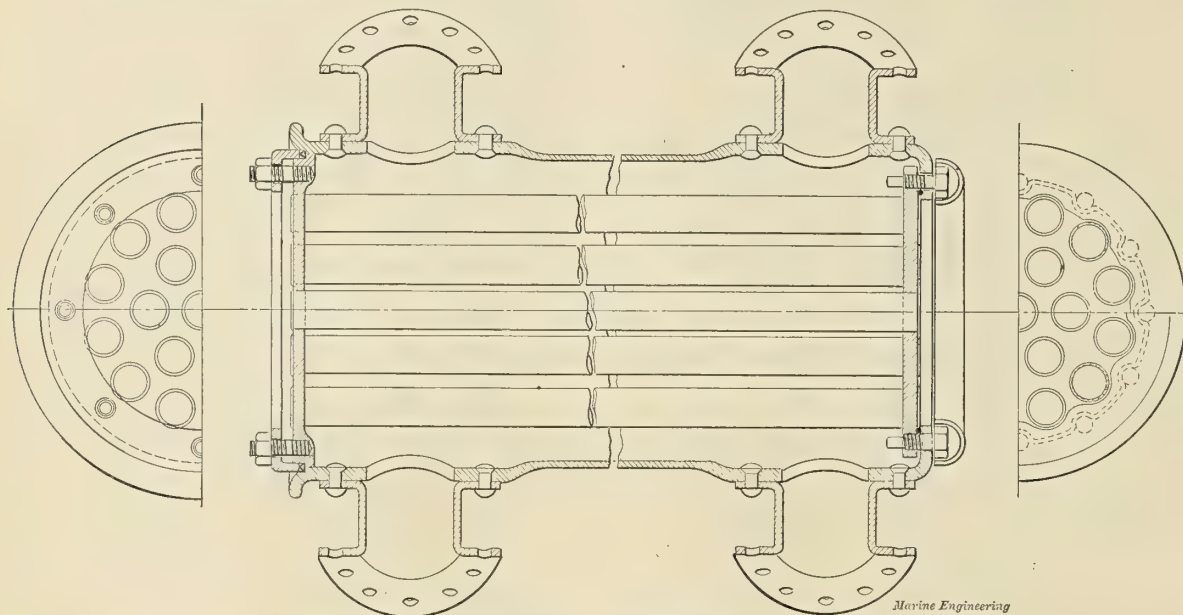


FIG. 1.—UNIT OF COWLEY & COOPER FIRE TUBE BOILER.

erence to the accompanying drawings it will be seen that the boiler consists of a number of tubular water

in. downcomers connect the steam drum and the mud drum. A casing covers the entire boiler. Nineteen

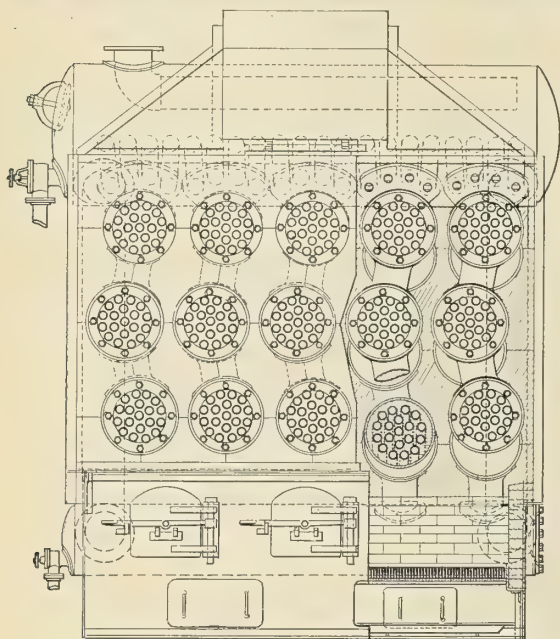


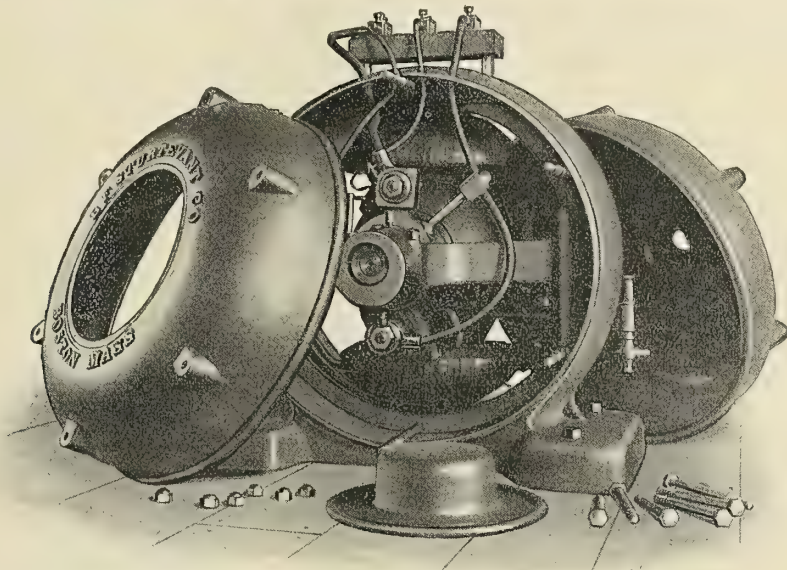
FIG. 2.—SECTIONAL ELEVATIONS OF COWLEY & COOPER FIRE TUBE BOILER.

shells 18 in. dia. and 8 ft. long placed in staggered vertical rows parallel to each other and longitudinally in a slightly inclined position over a furnace. The three shells in each vertical row are joined together

2 1-4 in. fire tubes parallel to each other are passed longitudinally entirely through each water shell, their ends being expanded into tube plates which close the corresponding ends of the water shell, as shown in

Fig. 2. Examining one water shell and its contained fire tubes, as shown in Fig. 2, the method of construction is as follows: The back tube plate is small enough to pass through the water shell, the joint between this tube plate and the end of the water shell, which it closes, is made by a round copper gasket. Bolts passing through the flanged end of the water shell are tapped into this tube plate and extend through into the water. By screwing down on these bolts the joint is effected on the copper gasket. A light cast iron guard is placed over the bolt heads to protect them from direct flame and the immersed ends of the bolts carry off the heat. The joint between the front tube plate and the water shell is made by a flexible V-shaped metal gasket placed in a recess similar to a stuffing box. A gland of wrought steel is forced down on this gasket to hold it and make the joint. When it is desired to clean the boiler the bolts in the back tube plates are removed and those holding the gland

this the gases are passed directly into the stack when first starting fires, also leaving the fire tubes free for examination, plugging, etc., and also reducing the rate of steaming. It has been the purpose to design a marine type of sectional fire tube boiler to carry very high pressures, to contain a sufficient volume of water and weight much less than the cylindrical or Scotch boilers in use. The fire tube type has been adopted because of the mechanical advantages of small tubes under external pressure, and because of the practical advantages in handling fire tube boilers at sea. The boiler consists of numerous small tubular boilers gathered together in one casing and all connected so as to discharge their steam into one steam drum. The cluster of fire tubes in each small boiler is made removable that both may be cleaned. The construction is entirely of wrought steel and the boiler can be built for high pressures without excessive weight of material. The units, or sections, of which the boiler is



STURTEVANT ENCLOSED ELECTRIC MOTOR.

at the front end slackened, and the cluster of fire tubes, together with the tube plates into which they are expanded, are withdrawn from their position in the water shell. By the removal of the fire tubes the water shell is rendered accessible. The baffle casings at the front and back ends of the water shells are made in sections. Room is provided in the design to admit a man between the water shells so that the exterior surfaces may be swept and examined. All the connecting necks are easily cleaned, also the few large water tubes at the upgoing end of the boiler. Ample manholes are provided in the steam and mud drums for examination and cleaning. The heat distribution is as follows: The products of combustion from the furnace pass, as indicated on the drawing by arrows, up and around the water shells, thence into the combustion chamber formed by the casing and steam drum, and finally through the fire tubes to the uptake and stack. The radiant heat from the furnace is taken up by the water shells. An auxiliary draft door is provided, as shown at A in Fig. 1, and by opening

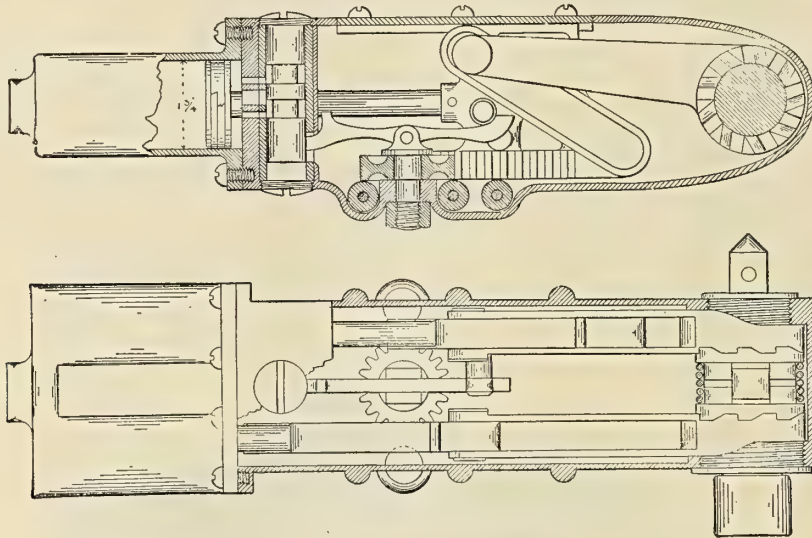
composed may be passed through the hatch of a ship and erected in place. The address of the designers is Everett, Mass.

Enclosed Electric Motor.

The bi-polar type of enclosed motor, the internal construction of which is illustrated in the accompanying engraving, is manufactured both as a motor directly connected to a propeller fan and as an independent machine. For the former purpose it is used on all sizes of fans up to and including the 54 in. For larger sizes the four and eight-pole types are employed. The motor is entirely enclosed, and thereby protected from dust, an important element in a machine used under these conditions. In order to avoid the excessive temperature which is incident to the operation of many enclosed motors, this type has been very carefully designed, so that a low temperature rise can be maintained without greatly increasing the size and weight above that of the ordinary open type. This machine is capable of continuous opera-

tion for ten hours, with a maximum temperature rise not exceeding 60 deg. F. Yokes extending out from the field ring support the armature shaft. The end casings are entirely independent and can be instantly removed to give access to the entire interior. The

continuously. At the base of each crosshead there is a rack, and between these racks a gear operates. The function of the gear is to transmit the power developed on the return stroke of the piston to the crosshead which is moving forward, thus delivering the power



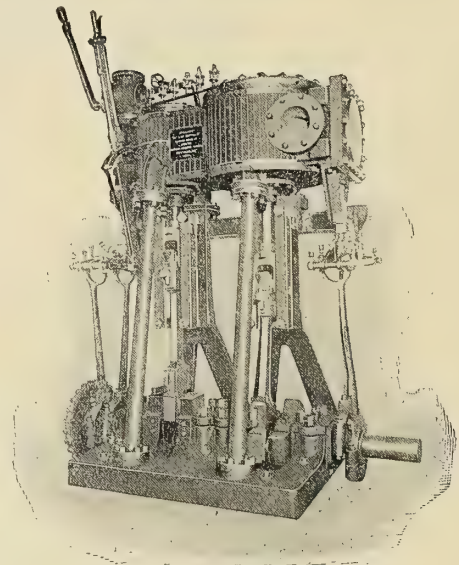
U. & W. PISTON AIR DRILL.

bearings and brushes can be reached by simply removing the caps in the center of the casings. The brushes are of hard carbon, in holders of a modified reaction type, which allows of easy adjustment when it becomes necessary to reverse the direction of rotation of the motor. The bearings are self-oiling and self-aligning, and fitted with composition sleeves, which are removable from the outer ends of the boxes. These motors, in sizes from 1-6 to 5 H. P., are built by the B. F. Sturtevant Co., Boston, Mass.

Piston Air Drill.

Among the late additions to the now long list of pneumatic devices is the U. & W. Piston Air Drill, manufactured by the Columbus Pneumatic Tool Co., Columbus, Ohio, an engraving of which is here presented. This drill has been designed with especial reference to work in close quarters where considerable power is necessary. The movement of the shaft is secured by a simple ratchet mechanism, consisting of two clutches and two arms. The arms are free to move about, but are prevented from moving along the shaft. The clutches are free to move along the shaft a distance of 3-32 in., but engage lugs on the shaft which communicate the rotary motion from the clutches to the shaft. The outer end of the arm engages the slot in the crosshead, and as the piston forces the crosshead back and forward, the arm moves up and down and about the shaft. On the forward stroke, the teeth on the arm engage those on the clutch and the shaft is rotated, but on the back stroke the clutch is forced out of engagement, and, slipping along the shaft, allows the arm to move freely about the shaft. It will be seen that, there being two arms which move in opposite direction, at the same time, the shaft is rotated

of both cylinders to the arm that is, at the time, rotating the shaft. The valve motion consists of a shifter and two piston valves, one inside the other. The inner or auxiliary valve is employed to set the main valve and derives its motion from the shifter which is operated by a pin extending from one of the crossheads. A forward movement of the crosshead



BELL MARINE ENGINE.

forces the shifter down, thus raising the valve; an opposite movement of the crosshead effecting the lowering of the valve. The main valve is set by live air properly distributed by the auxiliary. This simple shaft mechanism allows of small dimensions, it being

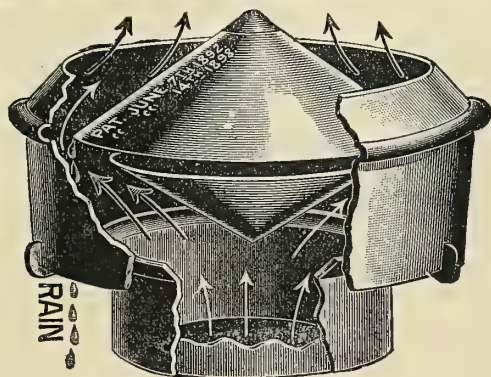
only 11-8 in. from the center of the shaft to the outer edge of the casing, and since the axis of the shaft coincides with the axis of the drill used, holes can be drilled, the centers of which are the above distance from a corner or flange. Its simplicity makes it easily cared for and makes repairs infrequent, and its light weight enables it to be easily handled by one man.

Vertical Marine Engine.

In the engraving on page 482 there is shown a fore and aft engine recently built by the Bell's Steam Engine Works of Buffalo, N. Y., for use in a fast steamer on Chautauqua Lake, N. Y. The engine was designed and built for a steam pressure of 250 lb. The cylinders are 12 in. and 26 in. dia. by 14 in. stroke and the bed plate is of the regular box type, with facing pieces to receive the front and back columns. The crank shaft is of forged steel 6 in. dia. The cylinders are supported at the back by cast iron columns. The crossheads are of open hearth cast steel with brass boxes in the connecting rods. In the front the cylinders are supported by wrought iron polished columns. The cranks are set at right angles to each other and the cylinders are provided with receivers in connection with the belt around them, which gives an effective steam jacket. The high pressure has a single piston valve and the low pressure cylinder is provided with an ordinary slide valve, both valves being operated by a Stephenson link of the double bar type. Piston and connecting rods are of forged steel, and the throttle is of the balanced type. The design of the engines was very carefully worked out on a basis of 600-700 ft. piston speed per minute, and great care was also taken to have all the reciprocating parts accurately balanced to avoid jar. The engine is of about 200 horse power.

Pancoast Marine Ventilator.

In the accompanying engraving is shown a section of a Pancoast ventilator manufactured by the National Pancoast Ventilator Co. of Philadelphia, Pa., for use on vessels and for buildings ashore. This

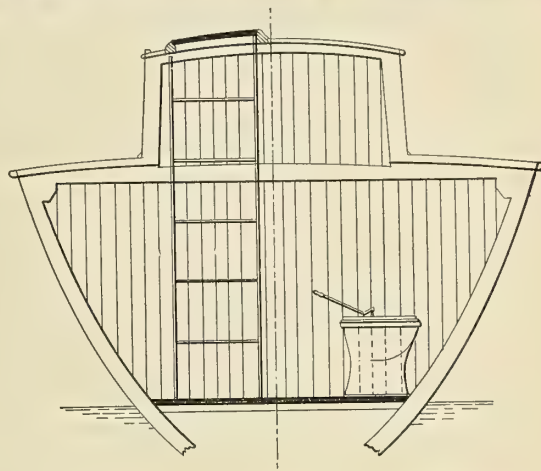


PANCOAST VENTILATOR.

ventilator is designed to be storm proof and it is especially adapted for use as an exhaust ventilator; in many instances on ships this form of ventilator being used for exhaust and the ordinary cowl used for intake.

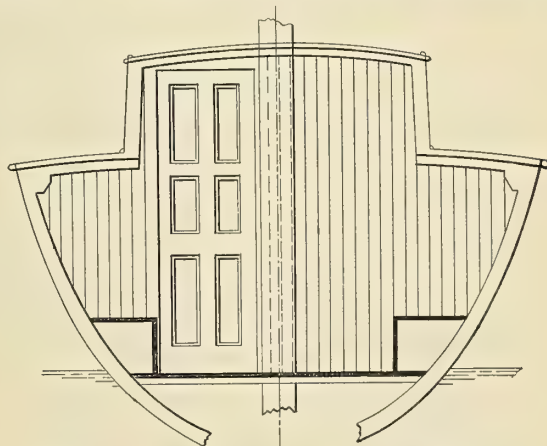
Auxiliary Hunting Yacht.

In the accompanying plans there is shown an auxiliary yacht built recently by the Gas Engine & Power Co. and Charles L. Seabury & Co., Con., for the special purpose of cruising in shallow waters on



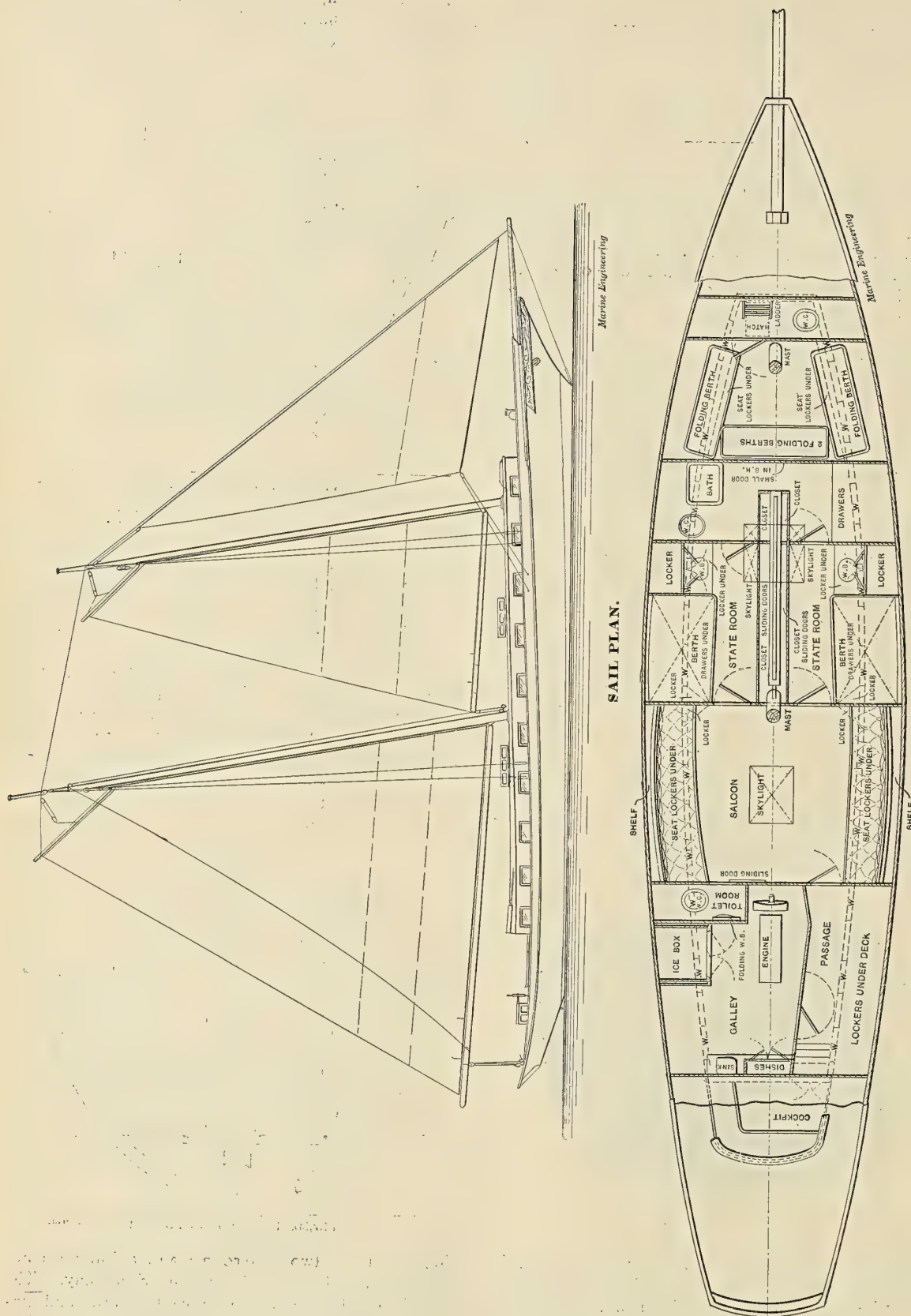
FRAME 9, LOOKING FORWARD *Marine Eng.*

hunting expeditions. The yacht is 68 ft. long over all and 15 ft. beam. The house extends to nearly the full length of the cockpit, giving all the inside accommodations possible, and by reason of the extreme light draft, which does not exceed 32 in. with full load, the freeboard is unusually high. The rig has been cut down for easy handling by a small crew, and the yacht has plain pole masts. The power plant is large in comparison with the equipment of most auxiliary craft, and it is the intention of the owner to use this quite extensively—probably more than the sail. The engine is of the builders' naphtha type, with three cylinders, and is rated at 24 horse power. It drives a 28 in. two bladed propeller of high pitch. Polished red mahogany is used for furnishing the



FRAME 11, LOOKING FORWARD *Marine Eng.*

saloon, and the two staterooms and adjoining compartments are finished in white mahogany. The yacht is fitted with a bronze centerboard, and has copper tanks fitted of sufficient capacity to carry fuel for a thousand miles continuous run.



SAIL AND ACCOMMODATION PLANS OF AUXILIARY HUNTING YACHT, BUILT AND EQUIPPED BY THE GAS ENGINE & POWER CO. AND CHARLES L. SEABURY & CO., CONS.

ACTION OF BILGE KEELS FROM A HYDRO-DYNAMICAL POINT OF VIEW.—II.*

BY G. H. BRYAN, F. R. S.

II.—EFFECT OF STREAM-LINE MOTIONS.

(6) When a cylinder of other than circular section is rotating in fluid, whether the rotational motion be steady or oscillatory, stream-line motions are set up, the effect of which is to cause the fluid to flow past the more protruding portions of the cylinder in the opposite direction to that in which the cylinder is turning. If a small lamina or paddle be fixed projecting from the cylinder where it can intercept this counter current, the increased relative velocity of the fluid increases the pressure on the lamina, which we shall assume to vary as the square of the relative velocity.

In the case of an elliptic cylinder whose longest and shortest diameters are in the ratio of 3 to 2, this stream-line motion would almost exactly double the pressure on a small lamina projecting from the extremity of the longest diameter.

For cylinders of section other than elliptical, the increase of pressure due to this cause depends, however, quite as much on the form of the section as on the ratio of its greatest and least radii, and it may be laid down as a general rule that, when the protruding parts are smoothly rounded, the stream velocity is small, while sharp bends produce a considerable increase in the stream velocity, until, when the two sides actually meet at an angle projecting into the fluid, the stream velocity becomes infinite at the angle, and the stream-line motion is replaced by discontinuous motion.

(7) The problem of the stream-line motions past cylinders of given section is, in general, very difficult of solution; but, by taking suitable forms for the stream function, we can obtain solutions for cylinders whose curve of section coincides with a given contour at any number of assigned points. In this way the stream-line motion could theoretically be worked out for a cylinder of section approaching to the midship section of a given ship to any degree of approximation. The calculation, however, becomes very complicated, if the section approximates to a highly angular form.

In the small time available for the preparation of this paper, it has only been possible to work out a few simple cases. The points by which the shape of the contour lines have been determined are shown in the figures; the intermediate form of the curves is merely roughly sketched in, and is not to be regarded as accurate.

For the section shown in Fig. 1, the pressure at A_2 is increased by about 35.7 per cent., although the longest radius only exceeds the shortest by about 13 per cent. It is to be noted that the points A_3, A_4, A_5 lie in a straight line.

Fig. 2 shows a section of rather theoretical interest, in which the increase of pressure at A_2 amounts to 46.85, say, 47 per cent. That only a difference of 11 per cent. exists between the cases represented in

Figs. 2 and 3 is due to the fact that the convex parts of both curves are very smoothly rounded, and the difference of form chiefly lies in the presence of re-entrant corners in Fig. 2, which are much less ef-

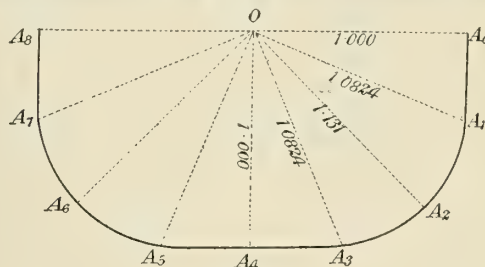


FIG. 1.

fective than protruding angles in modifying the pressures at the protuberant parts.

In Fig. 3 we have a nearer approximation to a square section, the points A_0, A_1, A_2 , as also the points A_4, A_5, A_6, A_7, A_8 , being in a straight line. In this case the stream-line motion increases the pressure at A_3 and A_9 by 67 per cent.

These results represent what happens when the moving body is a complete cylinder, symmetrical

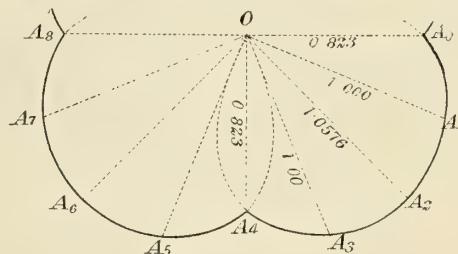


FIG. 2.

about O , rotating in an infinite mass of fluid. In addition to the stream motion producing counter-currents round the salient parts of the cylinder, it causes the fluid to move in the same direction as the cylin-

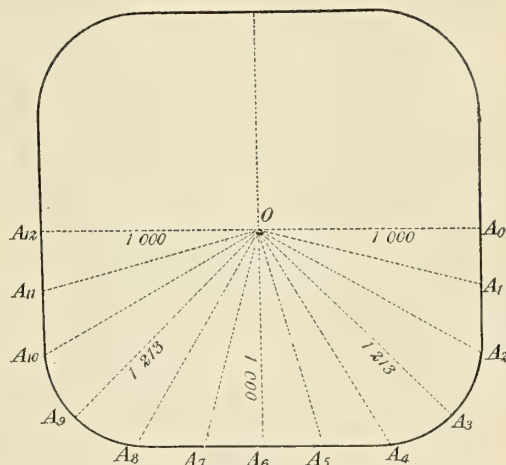


FIG. 3.

der at the points nearest the axis, such as A_0 . If we suppose the fluid, instead of covering the cylinders, to reach only half way up them, Figs. 1 and 3 give a fair general representation of the midship section, of

*Read before the Institution of Naval Architects, London.

RUSSIAN BATTLESHIP RETVIZAN.—The Russian battleship *Retvizan* was launched at the yard of the William Cramp Ship and Engine Building Co., Philadelphia, on Oct. 23. She was christened by the Rector of the Russian Orthodox Church of New York. The new battleship is the largest ever built in this country, and her total cost will be about \$3,000,000. She is of these dimensions: Length between perpendiculars, 376 ft.; beam, 72 ft. 2 1-2 in.; displacement, 12,700 tons, and a speed of 18 knots. Her batteries will consist of four 12-in., twelve 6-in., twenty 3-in. guns, and six torpedo tubes. The main belt of armor is 9 in. thick. Her protective deck has a thickness of 4 in. on the slopes and 2 in. on the horizontal portion. Arrangements have been made for insuring a continuous supply of ammunition to the rapid firing guns. The turrets are to be operated by electricity. Many of the auxiliary machines which are usually worked by steam will be operated by electricity.

FREIGHT STEAMER ASUNCION.—The freight steamer *Asuncion* was launched at the Lorain (Ohio) shipyard of the American Shipbuilding Co. recently. She is a sister ship to the *Paraguay*, which was launched a short time before. The *Asuncion* is of these dimensions: Length over all, 256 ft.; length of keel, 242 ft.; beam moulded, 42 ft.; depth moulded, 26 ft. 6 in. She is fitted with quadruple expansion engines, with cylinders 15 in., 23 in., 35 in. and 54 in. dia. and 36 in. stroke. Steam will be supplied by two Babcock & Wilcox boilers. These two vessels were designed for the seaboard trade, and are owned by the International Steamship Co., of which A. B. Wolvin, of Duluth, is manager.

SCH. ELEANOR A. PERCY.—The six masted schooner *Eleanor A. Percy* was launched at the yard of Percy & Small, Bath, Me. She is the largest vessel of her class ever built and is of the following dimensions: Length, 323.5 ft.; beam, 50 ft.; depth, 24.8 ft.; gross tonnage, 3,401.96 tons. The frame of the vessel is of hackmatack, and her hull is strengthened by steel braces. Her decks are of hard pine and her cabin fittings of quartered oak and mahogany.

S. Y. GENESEE.—The yacht *Genesee* was launched at the yard of Lewis Nixon, Elizabethport, N. J., on October 13. She is an auxiliary schooner designed by Cary Smith & Barbey, and is of the following dimensions: Length over all, 148 ft.; length on water line, 110 ft.; beam, 27 ft.; depth, 16 1-2 ft. The *Genesee* is building for James S. Watson, of Rochester, N. Y.

The Norwegian steamer *Veritas* came into collision with the Leyland line steamer *Devonia* from Boston in the Mersey on October 13. Unsuccessful attempts were made to beach the *Veritas*, but it became necessary to tow her over to the Liverpool side. The cable then parted and she came into collision with the steamer *Earl of Powys* and caused the latter to break from her moorings. Both steamers drifted down the river, and the *Veritas* crashed into two heavy iron booms, stretched from the pierhead at St. George's landing, carrying away everything above her deck and leaving her a submerged wreck. While drifting the *Earl of Powys* smashed her boats and lost her propeller. All of her crew managed to get to the dock wall.

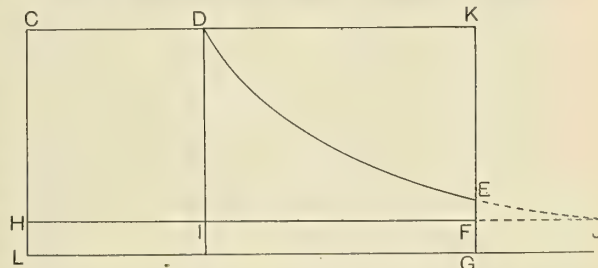
THE MARINE STEAM ENGINE.

AN ELEMENTARY DISCUSSION OF THE PRINCIPLES WHICH GOVERN THE ECONOMICAL USE OF STEAM FOR THE DEVELOPMENT OF POWER—II.

BY DR. WILLIAM FREDERICK DURAND.

In the last issue the general conditions which affect the question of steam engine economy were discussed. Among other points the cycle of the ideal engine was described and it was pointed out that the more nearly the cycle of the actual engine approaches that of the ideal, the better its efficiency. The question of the *expansion of steam* and its influence on engine economy has long held an important place as perhaps the chief factor in engine economy, and it may therefore be well to refer to this feature in somewhat further detail. From the standpoint of the discussion in the last issue, we should say that the expansion of steam is favorable to economy because it brings the cycle of operations nearer to that for the ideal engine. These points may, however, be treated in a more elementary manner as in the present issue, and we therefore proceed to discuss the question by the actual comparison of the two indicator diagrams given by an engine working with and without expansion.

Consider the two cards *C D I H* and *C D E F H*. The first is the card that would be given by using the



steam in an engine with stroke *C D* following to the extreme end, and then exhausting along *D I H*. The second card is such as would be given by the same steam used expansively cut-off taking place at *D* and the stroke continuing expansively to *E*. The back pressure in each case is represented by the line *H F*. The area *C D I H* represents the work in one case and the area *C D E F H* in the other, so that the difference or *D E F I* represents the gain by expansive working. In other words, if we use the steam full pressure up to *D* and then exhaust it, we throw away an amount of work measured *D E F I* which might be saved by expansive working. It is likewise true that the exhaust opening at *E* causes a loss of work *E J F* which might be saved by continuing the expansion down until the forward pressure falls to the back pressure as at *J*. It is rare, however, that we can afford cylinders of sufficient size to carry the expansion to such a point, and, as may be seen, the amount thus lost is smaller and smaller as the final pressure *E G* is nearer the back pressure *F G*.

To illustrate the gain by expansive working let us suppose the initial pressure *L C* = 100 lb., the back pressure *L H* = 3 lb., and that the cut off is at a

series of points .1 .2 .3, etc. Then neglecting the effect due to clearance, the number of expansions will be as 10, .5, .33, etc., and the ratio of saving will be as given in the following table. The numbers in the column headed e give values of the ratio $DEFI \div CDIH$, or the ratio of the amount saved by expansion to the amount done before expansion begins.

Point of Cut-off.	Expansion Ratio.	e .
.1	10.	2.11
.2	5.	1.55
.3	3.30	1.18
.4	2.50	.91
.5	2.00	.69
.6	1.66	.51
.7	1.43	.36
.8	1.25	.23
.9	1.11	.11
.10	1.00	.00

It will be understood that the figures of the above table refer to indicator cards such as those of the diagram in which there is no allowance for clearance, compression, rounding off of corners, etc. These conditions are of course taken in order to simplify the necessary computations. The nature of the results would, however, be the same in the actual case, and these figures may therefore be taken as sufficiently close indication for illustrative purposes.

It thus appears that the gain is proportionately greater the larger the number of expansions, and for the highest efficiency we should therefore carry the expansion to the highest limit. Practically there are two considerations which fix an early limit to this extension of the expansion range. The first is the limit of size. The greater the number of expansions the larger the engine and hence, especially for marine engines, we can seldom afford weight enough to give the number of expansions which other considerations might warrant. The second limitation comes from the increase of internal or cylinder condensation which increases with the number of expansions until finally the resulting waste would off-set the gain due to the increase in ideal efficiency.

This loss is decreased by the compounding of engines, so called, or by the splitting up of the total expansion into a series of steps in separate cylinders, as explained last month. Hence with multiple expansion engines we are able to employ higher rates of expansion without corresponding losses from cylinder condensation than with a single cylinder; and this is the real significance of the use of multiple expansion rather than simple engines.

Economy of the Actual Engine.—We have already seen that the highest possible efficiency of an ideal engine under usual conditions will be found between 25 and 30 per cent, while the actual engine at the best will realize only some 60 or 70 per cent of these figures, or an efficiency of say 15 to 20 per cent in good practice. Now one horse power is 33,000 ft. lbs. of work per minute, and from the value of the work equivalent of heat this is equal to $33,000 \div 778 = 42.42$ heat units per mt. Hence one horse power means the transformation of 42.42 heat units per mt. into mechanical work. It follows that the heat which must be supplied to the engine in order to provide for one horse power will be given by dividing this

number 42.42 by the efficiency at which the transformation is effected. But $42.42 \div 15 = 283$. + and $42.42 \div 20 = 212$. +. Hence, placing the limits a little more broadly, it appears that in good practice we shall require from say 200 to 300 heat units per mt. for each horse power developed in the engine. This corresponds to a range of 12,000 to 18,000 heat units per hour. Now remembering that each pound of steam brings to the engine roughly 1,000 heat units, it is clear that this will correspond to a range of steam consumption of say 12 to 18 lb. per I. H. P. per hour. These figures may be taken as covering the range of good practice from about the best at present attainable to a value only moderately fair for modern triple expansion engines, or very good for the usual type of compounds.

Again each pound of coal burned may be expected to furnish under good conditions some 9,000 or 10,000 heat units to the water in the boiler, or to transform some 9 or 10 lb. of water into steam. Hence the coal required per I. H. P. per hour will be given by dividing the heat units, or the lbs. of steam required by the amount of either which may be expected from one pound of coal. This will give a coal consumption of from about 1.2 to 1.8 lb. per I. H. P. per hour which may also be considered as representing the upper part of the range of good practice for triple and quadruple expansion engines under from moderately good to the very best conditions at present attainable.

For compound and simple condensing engines under good to moderate conditions the steam consumption will rise to from 20 to 30 lb. of steam, corresponding roughly to from 2 to 3 lb. of coal with good boiler economy, and to perhaps 2.5 to 3.5 lb. with poor boiler economy.

Farther along the line will come engines perhaps non-condensing, and of still lower efficiency, such for example as electric light, centrifugal pump, blower, winch, and steering engines. The steam required for them may rise to from 40 to 60 lb. or more per I. H. P. per hour, corresponding to a coal consumption of from perhaps 4 to 8 lb. according to the boiler efficiency.

Still lower in the scale of economy we find the ordinary direct acting pump. Such pumps operate in the steam cylinder with almost no steam expansion, and the piston speed is very low, thus giving full time for the transfers of heat which cause cylinder condensation. Due to these and other less important causes the steam consumption may rise to 200 lb. and more per I. H. P. per hour, while rarely can it be brought as low as 100 lb. This corresponds to a coal consumption from say 10 to 25 lb. depending somewhat on the efficiency of the boiler. In terms of absolute efficiency these figures correspond to from about 1 to 3 per cent, the values thus ranging downward from 15 to 20 per cent given above as the highest values at present attainable.

The submarine boat *Holland* has been placed in commission, and will be sent to the Naval Academy for practice work by the naval cadets.

PRACTICAL TRIAL OF LIQUID FUEL IN THE BOILERS OF S.S. COWRIE.

The oil tank steamer *Cowrie*, of the Shell Transportation and Trading Co., Ltd., of London (Messrs. M. Samuel & Co., managers), has recently arrived at the Standard Oil Company's wharves at Bayonne, N. J., in New York Harbor. The vessel is of 4,893 gross tons, and has a displacement of 6,900 tons at the load-water line. She was built by Armstrong & Mitchell, Newcastle-on-Tyne, England, in 1896. Her equipment is similar to other vessels of her class, as she is fitted with a triple expansion engine and three large single-ended Scotch boilers.

The Shell Transportation Co. has a large oil supply at its concession in the Koetei district, Borneo, covering 100 square miles, and on which work has recently been begun. The residue of the refining of this oil amounts to about half of the quantity exported, and the company proposes to sell this residue for liquid fuel. The crude oil itself can also be used for liquid fuel, while the refined oil is used in the manufacture of gas.

The *Cowrie* left the Tyne for Bombay on her last trip using coal as fuel. After her cargo was discharged at that port the oil burners were fitted, and she proceeded to the port of Balik Pappan, in the Koetei district of Borneo. From there she returned to London, stopping at Colombo, Suez and Port Said, and from London she sailed to New York.

There have been no radical changes made in order to adapt the power plant to the new system. The 800 tons of liquid fuel is carried in the cofferdams in the fore-peak, which were originally intended for water ballast. In the bunkers a space holding about 30 tons, and situated several feet above the tops of the boilers, has been made tight, and this tank feeds the oil burners by gravity, and is pumped full about once a day. The donkey boiler is also fitted with burners, and has a small gravity tank fitted above it.

The oil burners are of the Flannery-Boyd type, and are very simple in construction. To install these burners the grate bars, bearers and bridge walls were removed from the furnaces. A hole about 4 1-2 in. dia. was made in the fire doors and door liners, and the burners, which are shaped like a conical projectile about 3 in. dia., are placed in the center of these holes, the point of each projecting slightly beyond the door liner. Steam is used for spraying the oil, and the conical end of each burner has two annular openings, the size of which may be increased or decreased at will by screw-handles at the back of the burner. The outer opening connects with the steam, and the inner opening connects with the oil supply. The steam pipes are connected to the auxiliary steam line by a reducing valve, which maintains a pressure of 80 lb., and these, with the oil pipes, are run under the smoke boxes to fixtures on the furnace fronts, on the sides opposite the fire door hinges. From the fixtures the steam and oil pipes lead to the burner, one entering it from above and the other below, each having a plug-cock connection at the fixture so that the burner may be withdrawn from the opening in the fire door and swung off to one side as if it were on hinges, swinging opposite to the fire door hinges. By this means the door can be opened at any time and the furnaces examined.

The ash pits are fitted with plate doors and notched quadrants, so that the amount of air can be regulated.

It has been found impracticable to blow such a flame directly into the bare furnace, as the riveted seams at the furnace throat and combustion chamber would suffer, and the products of combustion would go through the boiler so quickly that there would not be enough heat absorbed, and a high funnel temperature would be the result. This difficulty has been obviated by fitting the furnace with fire-brick baffles. In the first place, the furnaces, which were of the Purves ribbed type, were laid with one course of fire-brick in a semicircle down from the center, leaving the crown of the furnace exposed. The sides and backs of the combustion chambers were likewise bricked up to the level of the bottom row of tubes. The first baffle is placed across the middle of the furnace, and consists of a cross of fire-brick, one leg horizontal and one vertical, and each about 10 in. square. The second baffle is built in the throat of the furnace, half in the furnace and half in the combustion chamber. It is a fire-brick wall in which the bricks were placed slightly apart, leaving a series of openings about 3 in. by 4 in., giving the appearance of pigeon holes. The flame from the burner impinges on the center of the cross-shaped baffle and is deflected, striking all around the sides, and slightly backwards. The second baffle at the throat still further retards the gas, and distributes it uniformly in the combustion chamber. It will be recognized that the fire-brick lining in the bottom of the furnace and combustion chamber is a great advantage, as the hot brick will tend to keep a uniform high temperature at these places and facilitate circulation at the bottom of the boiler; whereas in the coal fire the part of the furnace under the bars is always cool, due to incoming fresh air, and the bottom of the combustion chamber is usually filled with ashes, which likewise keep these plates cool, and these differences of temperature in the same parts of boilers always cause strains in the material, shortening the life of the parts.

From Bombay to Borneo and back to London the *Cowrie* burned the crude oil just as it comes from the wells. After some experimenting the engineers succeeded in getting good results. The boiler tubes remained clean and showed no deposits of tar or heavy substances. One difficulty in handling the crude oil direct from the wells lay in the fact that such oil contained considerable water, which at times caused the burners to sputter, and occasionally extinguished the flames. The hot bricks would often relight the flame, and when this did not occur great care had to be exercised in applying the torch, owing to the accumulation of inflammable gas. This difficulty was overcome, however, by periodically draining off the water from the bottom of the gravity tank. In the future this oil will be allowed to remain for a time in a settling tank at the wells, where the water can be drawn off before loading on board ship.

From London to New York the fuel was gas-house refuse mixed with the crude oil. This gave a little more trouble, as it required occasional sweeping of the tubes. The deposit, however, was not of a heavy nature; was easily removed, and did not materially diminish the efficiency of the boilers. When leaving England for Bombay, with coal fires, nineteen firemen and trimmers

were required, and after the installation of the oil burners ten of these were dispensed with, and the vessel proceeded with only nine men. As the main boilers have three furnaces each, making a total of nine furnaces, this amounted to three firemen a watch, or one man to three fires. When everything was working smoothly one man a watch could easily have attended to the nine burners, but as the firemen were all Chinese, and the installation was something out of the ordinary, it was considered advisable to retain at least nine men. On the trip to New York, when burning the mixture, it gave trouble occasionally by stoppages in the oil pipes at the valves. This is now obviated by putting steam connections to these pipes to blow them through when stoppages occur, as the clogging material is of an oleaginous nature.

It is evident that the careful and frequent adjustment of the burner valves is of prime importance. Any neglect of this kind caused as dense a smoke from the funnel as would be produced by soft coal, while under proper adjustment the escaping gas was colorless. The temperature of the stokehold was above normal, owing to the fact that the baffling of the flames heated the furnace fronts.

One objectionable feature about the installation lies in the fact that the owners selected a burner which requires steam for atomizing the oil, as this entails a great loss of fresh water. The ship originally had one evaporator, and two additional evaporators were added to help make up the loss, but even so the boilers were salted. The small donkey boiler, with two furnaces, is used to generate the steam for the burners, and in starting up, a wood fire is built in the boiler until there is 5 or 10 lb. of steam. Then the ashes are raked out and the burners started.

No data as to the relative performance of this quality of oil compared with coal has been secured as yet. Of course, the use of oil for fuel is nothing new, as it is used extensively in land practice and also for small boats, but so far steamship owners have been slow in adopting it for use in large seagoing ships. There is no doubt that the advantages, such as reducing the size of the crew, cleanliness in handling, and the small amount of time required to load, speak very much in its favor. The question of cost is the vital one. In regard to loading the fuel, it may be mentioned that the *Cowrie* took on 313 tons in 1 1-2 hours.

An objectionable feature of the burner is that it creates such a roaring noise. When the nine burners in this ship are all going conversation can only be carried on in the stokehold by the sign language. In a vessel of this class, where the machinery is located away aft, this feature is not of great importance, but in a passenger ship it might become very annoying. As all oil burners roar more or less, however, this criticism is not derogatory to the special type of burner used on this vessel.

A NEW ARMOR-PLATE ESTABLISHMENT.—For some time past Sir W. G. Armstrong, Whitworth & Co., Ltd., have been making extensive additions to their Openshaw Works, with the object of producing armor plates of the highest quality. These additions to buildings and equipment are now well on to completion.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—(1) At what temperature Fah. does coal oil (kerosene) freeze?

(2) What is the rule for finding the friction of air under pressure in pipes? MASTER MARINER.

A.—(1) In the first place it must be understood that kerosene oil is not a definite chemical substance, and that its properties depend largely on the particular proportions in which certain of the constituents are found. The chief constituents of kerosene oil form a series of chemical substances known as *pentane*, *hexane*, *heptane*, *octane*, *nonane*, etc., and containing in each molecule, respectively, 5, 6, 7, 8, 9, etc., atoms of carbon, while the number of hydrogen atoms is two more than twice the number of carbon atoms. Thus pentane would have the chemical formula C_5H_{12} , heptane C_7H_{16} , etc.

Now these various substances solidify at different temperatures in the neighborhood of 20 degrees below zero. It follows that when kerosene oil is cooled the first of these substances to solidify will make the oil cloudy and thick, and the process will gradually continue till it is entirely solid.

For commercial purposes the question of importance is not so much as to the temperature at which the oil becomes solid as the temperature at which it begins to become thickened by the solidification of one of its constituents, and its fluidity thus impaired. This may be termed the chill point, and with good commercial kerosene should not occur till the temperature is carried considerably below zero, though the presence of certain substances which solidify at higher temperatures might render it somewhat cloudy at temperatures close about zero.

(2) Various formulæ have been proposed for expressing the loss of pressure due to the flow of air in pipes. The simplest form may be expressed as follows:

$$p = .0000025 \frac{L v^2}{d}$$

in which:

p = loss of pressure in lbs. per sq. in.

L = length of pipe in feet.

v = velocity of flow in feet per sec.

d = diam. of pipe in inches.

The use of this formula may be illustrated by the following example.

Suppose 60 cu. ft. of air per minute is discharged through a 2 in. pipe 400 ft. in length, the initial pressure being 80 lbs. Find the loss of pressure at the discharge end.

The area of the pipe is 3.1416 inches, and the volume discharged is 60 cu. ft. or 103,680 cu. in. per minute. Hence the velocity of flow is $103,680 \div 3.1416$ in. per mt. = 33,000. This reduced to ft. per sec gives $33,000 \div (12 \times 60) = 43$.

Hence substituting in the equation above we have

$p = .0000025 \times 400 \times 43 \times 43 \div 2$ or $p = .9$ lb. or the pressure at the discharge end would be reduced about 1 lb. or to about 79 lb. per sq. in.

The North German Lloyd liner *Main*, which was burned in the dock fire at Hoboken, N. J., June 30, has been towed to the Newport News shipyard for complete repairs.

On the occasion of the visit of the Greek warship, *Navarchos Miaoulis*, to the port of New York last month, a silver loving cup with an appropriate inscription was presented to the vessel by Greeks resident in various parts of the United States.

Another steamship pier fire occurred at the port of New York, October 6, at the Atlantic Transport dock. The fire seriously damaged the structure, besides consuming a quantity of freight before the fire boat and land engines drowned it out. There was no ship in the berth at the time.